THURSDAY, MARCH 1, 1883

RECENT ARMOUR-PLATE EXPERIMENTS

AT the conclusion of their labours the "Iron Plate Committee" reported, in 1865, that the best material for the armour of war-ships was wrought iron of the softest and toughest nature. Steel, or steely iron, or combinations of iron and steel were all pronounced unsuitable for the purpose, after a long course of careful experiments. Accepting this verdict the designers of armoured ships continued to specify for soft iron armour, the makers of guns and projectiles aimed at the perforation of this kind of armour, and the manufacturers sought to secure the desired qualities of softness and toughness in the thicker and heavier plates which they were constantly being called upon to produce. All the armoured ships built from 1860 to 1876 were "ironclads," and in that time the thicknesses of armour plates carried on the sides or batteries of completed ships had advanced from 4½ inches to 14 inches, while the weights had risen from 4 or 5 tons to 20 or 25 tons. Greater aggregate thicknesses of iron had been arranged for prior to 1876. For example, the *Inflexible* had been designed to carry 24 inches of iron on her sides, but this was in two layers of 12-inch plates. The adoption of the so-called "sandwich-fashion" of armour plating was based upon experiments made at Shoeburyness, and it had certain advantages of a constructive character; it also enabled broader and longer plates to be produced within the fixed limits of weights with which the manufacturers could deal, and enabled them to insure excellence of quality which might not have been so certain of attainment in plates of 20 inches or upwards in thickness.

While the two great Sheffield firms and their rivals in France were thus developing the manufacture of iron armour plating, the Creusot Company, of which M. Schneider was the head, were attempting to reverse the verdict against steel armour, and to produce specimens which could hold their own against the best iron armour of equal thickness. The Italian Admiralty brought the claims of the rival materials to the test of experiment at Spezia in October, 1876. In order to decide on the kind of armour to be used on the *Duilio* and *Dandolo*, specimen targets were erected and a series of firing trials made against them on a scale of unprecedented magnitude. A gun weighing 100 tons, manufactured at Elswick, was brought to bear upon targets protected by iron or steel plates 22 inches thick, backed by great masses of timber and strong supports. Other guns of considerable weight and power were also used, but their performances were overshadowed by those of the monster weapon. The results of these trials may be briefly summarised. Against the 10-inch and 11-inch guns the 22-inch iron plates had a decided advantage over the steel plate of equal thickness. The penetration was somewhat greater in the iron plates, but the steel plate cracked badly. On the other hand, when the 100-ton gun was brought against the targets the iron plates and their backings were completely perforated as well as broken up: whereas the steel plate, although smashed to pieces, prevented the shot from passing through the backing. Various opinions were formed as to the deductions which should be made from these trials. On the one side it was urged that as steel plates of great thickness could be gradually cracked and destroyed by guns incapable of perforating them, steel ought not to be used instead of iron, which could be battered by a great number of projectiles from such guns, and be neither perforated nor cracked. On the other side it was maintained that there was small probability of any single armour plate on a ship's side being struck repeatedly in action; and consequently that the material should be preferred which could best resist perforation by a single projectile from the most powerful gun, even if the resistance to perforation involved the partial destruction of the plate struck. The Italian authorities adopted the latter view, and the *Duilio* and *Dandolo* have steel armour, being the first ships protected in that manner.

Although these steel armour plates were made in France, the French authorities did not follow the Italian lead and abandon iron armour. Nor was a similar course followed in England. Change was seen to be inevitable, but it was endeavoured to make the change in a direction which should combine the high resistance to perforation of steel with the power to resist cracking and disintegration possessed by tough rolled iron. To Messrs. Cammell and Co. of Sheffield belongs the honour of taking the lead in this direction; Messrs. Brown speedily followed, and the Admiralty gave substantial assistance in the conduct of the necessary experiments. In the earlier stages many failures and disappointments were experienced; but eventually better results were obtained, and "steel-faced armour" became recognised as the substitute for iron on English war-ships. Steel-faced armour, as the name implies, consists of a rolled iron back-plate, on the face of which is welded a layer of steel. The hard steel face resists perforation, and breaks up or deforms the projectiles, while the intimate union of the tough iron back with the hard steel face prevents the serious cracking which occurs in steel alone. Curiously enough the idea was not merely an old one, but a small plate made on this principle, 4½ inches thick, had been fired at in 1863. This early steel-faced plate was broken into two pieces at the first shot of a light gun, and was condemned by the Iron Plate Committee. Fourteen years later plates of a similar character, so far as the combination of steel and iron is concerned, but of improved manufacture, were successfully resisting three shots, either of which would have perforated an iron plate of equal thickness.

The first steel-faced plates were used on the *Inflexible's* turrets: they were 9 inches thick, worked "sandwich-fashion" outside 7-inch iron armour. It was part of the contract that a test-piece from each steel-faced plate should be fired at with a 12-ton gun, and should receive three shots without being broken up or perforated. This was considered to be a very severe test at the time, and undoubtedly was so when the novel conditions of the manufacture are considered. It was successfully met, however, and from that time onwards the manufacture has steadily improved. As an indication of what has been done, it may be stated that steel-faced plates 11 inches thick have received no less than eight shots from the 12-ton and 18-ton muzzle-loading guns, with battering charges and at 10 yards' range, without perforation or

very serious cracking, this enormous "punishment" having been sustained by an area of 48 square feet only. Most of the trials made against steel-faced armour have been against plates from 10 to 12 inches in thickness. For thicknesses up to 12 inches it is probably within the truth to say that for *normal impact* the steel-faced plates of recent manufacture have been equal in their resistance to perforation to iron plates 25 to 30 per cent. thicker and heavier. For oblique impact the hard armour is probably still more superior to iron, glancing the projectiles at angles of obliquity when they would have "bitten" into the iron. A few experiments have been made in this country and abroad on much thicker steel-faced plates, ranging up to 18 or 19 inches in thickness, and of these the most recent and important are the trials made at Spezia in November, 1882. Three targets were constructed for these trials, the armour plate on each being nearly 11 feet long, 8½ feet wide, and 19 inches thick. One of the targets was covered by a steel-faced plate made by Messrs. Cammell, another by a steel-faced plate made by Messrs. Brown, and the third by a steel plate made at Creusot. All three plates were similarly backed and supported by 4 feet of oak; the Creusot plate was fastened by no less than 20 bolts, and the Sheffield plates had only 6 bolts each. Against these targets the 100-ton muzzle-loading gun was brought into action. At first the powder-charge used (329 lbs.) was that which gave such a velocity to the chilled cast-iron projectiles—2000 lbs. in weight—as would have perforated a 19-inch iron armour plate. The actual penetrations were from 3½ to 5 inches in the steel-faced plates, and 8¼ inches in the steel plate, showing that the actual superiority of all the plates over iron considerably exceeded the estimate. The steel plate did not crack at the first shot: the steel-faced plates did, but not to any serious extent. Next followed a more severe attack, the powder charge being increased to 480 lbs., giving the projectiles a velocity estimated to be capable of perforating about 24 inches of iron armour. The total energy of the projectile moving at this velocity exceeded 33,000 foot-tons. All the plates were broken into pieces by this terrific blow. The steel plate was split into six pieces, but the numerous bolts held these pieces in position, and still preserved the defensive power of the target. Each of the steel-faced plates was broken into five pieces, and on account of the fewness of the bolts these pieces fell to the ground, leaving the targets uncovered. The whole of the chilled cast-iron shots were broken up on impact, and the penetration into the steel-faced plates was less than that in the steel plate. At this stage the comparative tests ended. A third round was fired, with the heavier charge and a steel projectile against the steel plate. The shot was stopped, the penetration was only 7 inches, but the plate was broken up, and the backing seriously splintered. A fourth round was fired at this target and completely wrecked it.

On a review of all the circumstances of the experiments, it must be admitted that the greatest success was attained by the steel plate, although this must be attributed rather to the number and excellence of its fastenings than to superiority in quality of the plate over the steel-faced plates. The latter proved themselves less penetrable than the steel plate, and had rather the advantage as regards fracture at the end of the first two series of rounds; but they were insufficiently secured. One definite lesson to be learned from these experiments is, therefore, that a larger number of bolts is needed for a given area of steel or steel-faced armour than has been commonly used. Another lesson taught by these trials is that the steel armour plates of Creusot manufacture in 1882 are far superior to those made six years earlier. It is not at all probable that light guns such as broke the 22-inch steel plate to pieces in 1876 would have been equally effective against the 19-inch plate recently tested. In both cases the plates were made specially for the firing tests, and they may not have been "merchantable articles" in the sense of representing large quantities of steel armour. But nevertheless this 19-inch plate shows what can be done with steel, if cost is of secondary importance. Authoritative statements are wanting of the actual processes of manufacture, or of the cost of production. It is reported that the 19-inch plate was hammered down from an ingot three or four times as thick as the finished plate, and that the face was oil tempered. If this is correct the cost must be high, and probably as great as, if not greater than, that of steel-faced plates. Moreover if such an amount of "work" has to be put into steel plates in their conversion from ingots into the finished forms, then no great economy or advantage can result from the power which the maker has to cast steel ingots in special shapes or sectional forms. The Creusot Company use a soft steel containing perhaps three-tenths to four-tenths per cent. of carbon, give it toughness by means of a large amount of hammering, and harden the face by oil tempering. On the contrary, the Sheffield firms, as the result of numerous experiments, use a hard steel for the face, the percentage of carbon amounting to about twice that in the Creusot plate, and support this by a tough iron back. With this hard steel, oil tempering does not appear to be beneficial, although with softer steel it undoubtedly is an advantage. These steel-faced plates which were tested at Spezia were really samples of large quantities made at Sheffield in the same manner. Probably equally good results would have been obtained if any one of the batch of plates represented had been selected for test. In this respect, therefore, there is a marked difference between the test to which the two manufactures were subjected.

As between the steel and steel-faced plates tried at Spezia we may assume that there is no notable difference in resistance to perforation or to fracture. Possibly, with equally good and equally numerous fastenings the steel-faced plates would have had some slight advantage, and in other trials mentioned later on steel-faced plates have had a decided advantage. Supposing no important difference to exist, then the choice between the two kinds of armour will be governed by their relative prices; and how these compare, we have no means of judging, but it seems probable that the steel-faced plates would be at least as cheap as steel plates made in the manner described above for the steel test-plate.

It may be convenient in this connection to briefly describe the mode of manufacture of steel-faced plates. Messrs. Cammell prefer to pour the molten steel on to the face of a wrought-iron plate which has been brought to a good welding heat. The layer of molten steel is surrounded by a frame of wrought-iron which has

previously been attached to the iron plate; and it is pressed against the surface of the iron plate by a cover carried by an hydraulic ram, until the welding is complete and the steel has solidified. Messrs. Brown prefer first to roll a steel face-plate as well as an iron back-plate, and then to raise both to a welding heat; the molten steel is afterwards poured into a space left between the two, and hydraulic pressure is applied until the solidification has taken place. The remaining processes are similar in the practice of both firms. After welding has been completed, the whole mass is reheated and rolled down to the finished thickness of the armour plate. The steel face is usually about one-half the thickness of the iron back, and it is a curious fact that the iron and steel maintain their relative thicknesses as the rolling proceeds, even when the reduction in thickness during rolling is very considerable. This reduction varies from one-half for thin armour-plates, up to 10 or 11 inches in finished thickness, to one-third with 18 to 20 inches of finished thickness. Some competent authorities consider that too little work is done in the rolls on the thicker plates, but there is a need for further experiment to show whether this view is correct. Whatever may be the cause, it would seem that the best results so far have been obtained with steel-faced plates below 12 inches in thickness.

Simultaneously with the Spezia experiments another competition was proceeding, near St. Petersburg, between steel-faced and steel armour. The plates tested were 12 inches thick, 8 feet long, and 7 feet wide. They were first fired at with the 11-inch breech-loading gun, throwing a 550-lb. chilled cast-iron projectile, with a powder charge of 132 lbs. The velocity of the shot was 1500 feet per second. Messrs. Schneider supplied the steel plate, which was fastened with twelve bolts. Messrs. Cammell made the steel-faced plate, which had only four bolts in it. The first blow on the steel plate broke it into five pieces; the projectile was destroyed, but it penetrated 13 inches into the target. A blow of equal energy on the steel-faced plate produced only a few unimportant cracks in the steel, and the penetration was about 5 inches only. Three out of the four bolts were, however, broken. A second shot was then fired at each plate with 81 lbs. charge. The steel plate was broken into nine pieces, and the penetration was 16 inches: whereas on the steel-faced plate the principal effect produced was to break the only remaining bolt and to let the plate fall to the ground, face downwards. The back of this plate was perfect, and the target behind the plate was uninjured. In this trial the steel-faced plate proved greatly superior to the steel, but had insufficient fastenings. It is proposed to increase the bolts in number, re-erect the plate, and continue the trial, of which the further results cannot fail to be interesting.

This contest between steel and steel-faced armour must not be allowed to withdraw attention from the great superiority of both, in certain respects, to iron armour. Even as matters stand, either of these modern defences is greatly to be preferred to their predecessor. Against this hard armour chilled cast-iron projectiles break up in a manner never seen with soft iron. Projectiles of this kind are virtually impotent, and must be replaced by more expensive, harder projectiles, if steel or steel-faced armour is to be attacked. Even with steel projectiles results cannot be obtained such as were possible with iron armour. Perforation of armour by shells carrying relatively large bursting charges is no longer a possibility: and the heaviest gun yet made cannot drive its projectiles through a thickness of hard armour only three-fourths as great as the thickness of iron which it it could perforate.

The use of steel and steel-faced armour will involve many experiments to determine not merely what descriptions of projectiles are best adapted to damage or penetrate it, but what are the laws of the resistance of such armour to penetration and disintegration. All the formulæ based on experiments with soft iron armour and chilled cast-iron projectiles are inapplicable under the new conditions. Perforation is no longer to be feared as the most serious damage likely to happen to armour plates: more moderate thicknesses of hard armour suffice to stop the projectiles from the heaviest guns than would have been considered possible a short time ago. Instead of perforating 19 inches of steel or steel-faced armour, the projectile of the 100-ton gun with a given velocity only penetrates 8 inches into the plates. But, on the other hand, the possible disintegration and fracture of the armour plates are becoming important matters. Makers of armour plates have to endeavour to produce materials which shall resist fracture as well as penetration, and the only proof of their success or failure is to be found in the results of actual trials. Experiments are equally essential to progress in the manufacture of guns and projectiles. The example set by Italy must be followed; the necessary experiments must be on a large and costly scale, and they may lead to many departures from former practice. But if real progress is to be made in the armour and armament of ships, it must be prefaced by experiments beside which those of the former Iron Plate Committee will appear insignificant.

In conclusion it may be stated that although iron armour has been practically superseded for the sides and batteries of war ships, it is still preferred for decks. Experiments have shown that for angles of incidence below 20 degrees, and for such thicknesses—not exceeding 3 or 4 inches—as are used on decks, good wrought-iron is superior to both steel and steel-faced plating. The explanation of this departure from the laws which hold good for thicker plates and greater angles of incidence cannot be given here, but the fact has been established by elaborate trials made in this country and abroad.

SMOKE ABATEMENT

Report of the Committee of the Smoke Abatement Exhibition. (London: Smith & Elder, 1883.)

THIS volume, which has just been issued, presents many points of interest, as it is the outcome of the labours of a Committee formed in 1881 with a view to ascertain what means could be adopted to check the growing evils arising from the evolution of smoke which attends the combustion of bituminous coal. It may be said to be the continuation of work undertaken by the several Parliamentary Committees which met in 1819, 1843, and in 1845. In the previous efforts attention appears to have been mainly directed to lessening the

nuisance arising from smoke from factory and other furnaces, but in the present movement it is evident that the importance of the domestic fireplace as a foe, if not the chief one, to the purity of the air of cities, has been generally recognised and has been the main object of attack.

It is not a little remarkable that, although elaborate experiments have been made from time to time with a view to ascertain the nature and composition of the gases generated in furnaces, but little attention has been devoted to the gases given off from stoves and grates. On the Committee of the recent Smoke Abatement Exhibition chemists were well represented, and this brief notice will mainly refer to the general chemical results that have been obtained.

The examination of the gases withdrawn from flues to which stoves and grates were attached, was intrusted to Prof. Chandler Roberts, who at first considered that the analysis of representative samples might best be made by the aid of the rapid methods of gas analysis arranged by Orsat. In view, however, of the peculiar conditions under which the tests had to be made, and bearing in mind that more than one hundred appliances were submitted for testing in the limited time during which the Exhibition was open, Prof. Roberts submitted a plan to the Committee which received its approval.

He points out in his report that the first researches on chimney gases are due to Péclet, who published some results of analysis in 1828, but Péclet's results and those of different experimenters who followed him were open to the objection that the samples submitted to analysis were only small fractions of the total gases in the flues, and as the samples were not taken with sufficient frequency they could not represent the mean composition of the gaseous mixture passing up the chimney. This grave defect was, however, remedied by Scheurer-Kestner in an elaborate research on the composition of the flue-gases of boiler furnaces, which will always be the basis of future experiments in this direction, and to which frequent allusion is made in the Report. The details of the method adopted are given in the Report itself; it will be sufficient to say here that the gases were withdrawn through a fine slit in a tube extending across the flue, an arrangement which rendered it possible to draw the gases uniformly from the entire diameter of the ascending current of gas in the flues. The effluent gases were withdrawn by aspiration through a tube loosely filled with asbestos to retain the solid particles of carbon and soot; they then passed through a U-tube filled with chloride of calcium to absorb water, and thence through three U-tubes filled with soda-lime to absorb carbonic anhydride; the gases were then led to a tube of porcelain filled with cupric oxide and heated to redness by means of a small furnace. The complete combustion of the remaining gases was thus effected, the carbonic oxide being burnt to carbonic anhydride, and the hydrocarbons and free hydrogen to aqueous vapour and carbonic anhydride; the water was retained in a U-tube filled with chloride of calcium, and the carbonic anhydride in two other soda-lime tubes; the residual gases (unconsumed oxygen and nitrogen) then passed to the aspirator, a chloride of calcium tube being interposed to prevent any moisture from the aspirator from penetrating the system of tubes.

It will be evident that this plan renders it possible to compare the relative proportion of the completely burnt products of combustion with those in which combustion has been imperfect. With regard to the proportion of carbon lost as soot, the evidence afforded by the results of the tests made at the Exhibition, although they do not unfortunately render it possible to give a clear and precise answer to the question, are sufficiently definite to show that the amount probably does not exceed 1 per cent. of the total carbon in the fuel, and is in many cases far less.

The coal used in testing the grates and stoves was either 'Wallsend,' which yielded 67·1 per cent. of coke, or Anthracite, giving 94 per cent. on distillation in a closed vessel.

With regard to the completeness of the combustion, the carbon present in the form of carbonic anhydride varied in relation to that present as carbonic oxide and as hydrocarbons, C_xH_y, within the limits of 1,000 to 4 and 1,000 to 375, but of the whole eighty-six tests in only three was the number indicating imperfect combustion below 10, and in only nine cases was it above 200, and six of these nine cases (three grates and three stoves) were worked purposely for "slow combustion."

The total amount of carbon present in the gases ascending the flue (either in the free state or combined with carbon) bore a relation to the hydrogen present which varied between the limits of 1,000 to 8 and 1,000 to 259, the latter probably being due to the fact that the grates and stoves were tested whilst the mortar in which they were set was still wet.

The mean of the results of the tests of the seventeen best grates shows that the loss of carbon in the form of carbonic anhydride and hydrocarbons is about 3·4 per cent. of the carbon in the fuel used (in the case both of Anthracite and Wallsend), the mean for the whole of the grates being about 9 per cent. of the total carbon.

The comparative imperfection of the combustion shown in some of the tests is hardly to be wondered at when it is remembered that the bituminous coal employed yielded on distillation no less than 32 per cent. of volatile matter, and that in the case of many of the appliances the cold fuel was simply charged on to the top of a mass of coal already in the state of incandescence.

Professor Roberts cautiously points out that all that has hitherto been done in this series of tests "merely renders it possible to select certain typical appliances which deserve more detailed examination." He appears, however, to have spared no pains to render this very laborious investigation as complete as the circumstances allowed, and the Chemical section of this Report is certainly one of the most important contributions ever made to our knowledge of the combustion of fuel.

E. FRANKLAND

NORTH AFRICAN ETHNOLOGY

Sahara und Sudan: Ergebnisse Sechsjähriger Reisen in Afrika. Von Dr. Gustav Nachtigal. Part II. (Berlin: 1881.)

NEARLY a decade has elapsed since Dr. Nachtigal's return to Europe after his travels in East Sahara and Central Sudan during the years 1869-74. Most of the geographical and ethnological results of his researches

in that region have already appeared at various times in the memoirs of the *Gesellschaft für Erdkunde* and of other learned societies. But the issue of the monumental work embodying all the details in a permanent form is proceeding at a very slow rate. The first part, covering the years 1869-70, did not appear till 1879, and an interval of two years elapsed before the publication of this second instalment, which, although forming a bulky volume of 790 pages, gets no further than the first days of September, 1872. In the preface the delay is attributed mainly to the time occupied in the tedious process of sifting the ethnological and especially the linguistic materials brought home by the traveller. The help afforded by Rudolf Prietze in arranging these materials is handsomely acknowledged in the preface, where occasion is also taken to express regret for omitting to give the source of the familiar mailclad, mounted Bornu warrior borrowed in Part I. from Denham and Clapperton's work, attention to which oversight had been called in our review of that volume (see NATURE, vol. xxi. p. 198).

The three books forming the present volume embrace the trips made to Kanem and Borku north of, to Baghirmi south of, Lake Chad, and to the islands in the lake itself. Separate chapters of great permanent value are devoted to the main geographical features of these regions, and to the history and complex ethnical relations of their inhabitants. Here special attention is naturally claimed by the mysterious Tubu people of the East Sahara, and a serious attempt is made to explain their relations on the one hand to the Hamitic Tuariks (Berbers) of the West Sahara, on the other to the Negro races of Sudan.

The Tubu, that is, "people of Tu" or Tibesti,[1] are by Lepsius[2] with great probability identified with the Garamantes of Herodotus (iv. 183), whose capital was Garama (Edrisi's Germa) in Phazania (Fezzan). Ptolemy, who places the Garamantes in the same region, that is, in the Libyan Desert (Sahara) south of the Syrtis Major (Gulf of Sidra), already speaks doubtfully of their ethnical affinities, and seems disposed to affiliate them rather to the Ethiopian (Negro) stock.[3] Later on this position is disturbed by Leo Africanus, whose fifth great division of the Berbers are the Gumeri (Garamantes?), whom he elsewhere calls Bardæi (Bardoa). These Bardæi, whose name appears to survive in the *Bardai* oasis of Tibesti, are accordingly identified by Vater with the Tubu, and by him grouped with the Berbers.[4] Now comes Lepsius, who again removes the Tubu from the Libyan (Berber) connection, and with Ptolemy transfers them to the Negro group. He admits a strong modification of the original dark, and a corresponding assimilation to the Libyan, type. But this is attributed to their position along the great historical trade route across the Sahara between North Africa and the Chad basin, while their language is regarded as decisive proof of their Negro relationship.[5]

And thus this interesting, if somewhat troublesome, nomad race has continued throughout the historic period to occupy a dubious ethnological position between the surrounding Hamitic and Negro peoples. That Dr. Nachtigal should attempt to grapple with the problem was inevitable, and although his own inferences are vague and hesitating, he at all events supplies ample material for a satisfactory solution. As in so many other anthropological fields, the difficulty turns, so to say, mainly on the collision between ethnical and philological interests. The present physical resemblance of the Tubu to their western neighbours, the Berber Tuariks, admits of no doubt, and this resemblance increases as we proceed from the Dasa, or southern, to the Teda,[1] or northern, division of the race. In fact there is here the same gradual transition between the Hamites of the Sahara and the Negroes of Sudan, which is found further west all along the borderlands from Bornu to the Atlantic, and which is conspicuous especially in the more or less mixed Sonrhay, Pul, Hausa, and Toucouleur nations of the Chad, Niger, and Senegal basins. To these correspond in Central Sudan the Negroid Kanuri, Kanembu, Baele, and Zoghawa peoples,[2] while the same complexity is presented in the Nilotic regions, where the Nuba family merges imperceptibly north and south in the Egyptians and Negroes of the White Nile.

But Lepsius (*op. cit.*) now holds that the two elements have become interpenetrated throughout the whole of the Sudan, which he consequently regards as an intermediate zone of transition between the intruding Hamites from Asia and the autochthonous Negroes, whose original domain is relegated to the southern half of the continent. In this scheme, which thus recognises in Africa only two fundamental racial and linguistic types, what place can be assigned to the Tubu? We have seen that Lepsius himself disposes of the question by regarding them as originally Negroes assimilated physically to the Berbers, while retaining their primitive Negro speech. If this view could be accepted, we should have an instance of the linguistic surviving the ethnical type, a theory in which anthropologists would in any case be slow to acquiesce. But Dr. Nachtigal's researches, while confirming Barth and Koelle's conclusions regarding the intimate relation of Tubu to Kanem and Kanuri, also show that this group is fundamentally distinct from the Bantu, that is, from the typical Negro linguistic stock of Lepsius. If it could be affiliated to the Hamitic family, there would be no further difficulty as to the ethnical position of Tubu. But Nachtigal also shows that it differs quite as radically from Hamitic as it does from Bantu. His inquiries have in fact resulted in the discovery of an independent and widespread linguistic family corresponding in the East Sahara and Central Sudan to the northern Hamitic and southern Bantu groups. The source, or at least the most archaic known form, of this family is the Teda, or northern Tubu, whose direct offshoots are the more highly developed Dasa, or southern Tubu, the Kanem north of Lake Chad, the Kanuri of Bornu, the Baele of Ennedi and Wanyanga, and the Zoghawa of North Dar-Fur. More distant members appear to be the Hausa, Fulu, and Sonrhay of

[1] Cf. *Kanem-bu* = people of Kanem, where *bu* is the pl. of the personal postfix *ma*. answering to the personal prefix *m*, pl. *ba*, *wa*, cf the Bantu races, as in M'Ganda, Waganda; and to the *be* of *Ful-be* = "Pul people."

[2] *Nubische Grammatik. Einleitung.*

[3] Οὗτοι δὲ καὶ αὐτῶν ἤδη μᾶλλον Αἰθιόπων, i. 8.

[4] "Mithridates II.," p. 45 of Berlin ed. 1812

[5] "Ursprünglich ein Negervolk," *op. cit.*, *Einleitung*, xlviii.

[1] In this word *Teda* we have apparently the root of the *Tedamensii*, a branch of the Garamantes placed by Ptolemy south of the Samamycii in Tripolitana. If my identification is correct, it gives us a fresh proof of the identity of the Garamantes with the Tubu.

[2] See my paper "On the Races and Tribes of the Chad Basin," NATURE, vol xv p. 550.

West Sudan, the Logon, Bagrimma (Baghirmi), and Mandara (Wandela) of the Shary basin, and the Maba of Wadai. But the actual relationship of these and other outlying branches to the main trunk can only be determined by future research. Meantime, Dr. Nachtigal rests satisfied with having demonstrated the existence of this widely-ramifying family and its radical difference both from the Hamitic and Bantu groups. "How far the relationship may extend will be made more and more evident by a further study of the Sudan languages, especially the Hausa, Masa, Bagrimma, Maba. For the present it is enough for me to have established the relations of the Tubu dialects to each other, and of both to the Kanuri and Baele" (p. 209).

But when he comes to the consequences of his premisses he speaks with singular hesitation, as if overweighted or hampered by the brilliant generalisations of Lepsius. The fact is, this theory of the three zones leaves no room in Africa for the great linguistic family which Nachtigal has nevertheless discovered there. But instead of boldly giving up the theory, he timidly suggests alternatives, in order somehow to reconcile it with the actual conditions. After clearly showing the independent position of Tubu, he leaves the reader to choose between a possible "extremely remote connection with the Negro languages, or, if it be preferred, to regard it as a distinct species, which has held its ground between the Negro and Hamitic linguistic types" (p. 201). Most ethnologists will probably be prepared to accept the latter alternative, even at the risk of adding one more to the two "linguistic types" which alone Lepsius will tolerate. The only point of contact between Tubu and Bantu seems to be the absence of grammatical gender, a negative feature which both share with a thousand other languages in the Old and New Worlds. Yet apparently in order to save Lepsius's scheme, Nachtigal is content on this weak ground to allow a connection between Teda and Negro, adding, still more inconsequently, "in which case, considering the vagueness of the concept 'Negro' (bei der Unbestimmtheit des Begriffes 'Negro'), there can certainly be no objection to group the Tubu themselves with the Negroes, although, taking the word in its ordinary sense, in other respects they essentially differ from them" (p. 209). So the Negro—that is, the most marked of all human varieties—is frittered away to a "vague concept," because Tubu is a no-gender language, or because Lepsius will allow only two linguistic types in Africa.

But by getting rid of this theory, an easier exploit than getting rid of the Negro, everything will fall into its place. The consideration that the centre of evolution of the Tubu group lies, not in Sudan, but in the Sahara, far north of the original Negro domain, placed by Lepsius south of the equator, would almost alone suffice to separate it from that connection. Dr. Nachtigal himself shows that Teda, or northern Tubu, represents the germ, of which the southern Dasa, Kanuri, Baele, &c., are later developments. He also shows that the migrations, as was natural to expect, were always from the arid plains and uplands of the Sahara to the fertile region of Sudan. Except under the lash of the slave-driver, the Blacks seem never to have moved northwards. But we have seen that the roving nomads, Tuariks in the west, Tubu in the east, have everywhere, all along the line, penetrated from their desert homes into the "Black Zone." The inference seems obvious. Nachtigal himself regards the Tubu as "a thoroughly pure, homogeneous people (*eine durchaus reine, homogene Bevölkerung*), unmodified by any changes from remote times" (p. 190). He also shows their close physical resemblance to the Tuariks (Berbers) of the western Sahara, and their essential difference from the Negro type. The anthropologist will not hesitate to remove them from the latter and group them with the former race. The Tubu and Berbers are thus ethnically two slightly differentiated branches of the Hamitic section of the great Mediterranean (Caucasic) division of mankind.

From this standpoint the Tubu speech, although as radically distinct from the Hamitic as it is from the Bantu, will no longer present any difficulty. In Europe the Mediterannean races have developed at least one radical form of speech, the Basque; in Asia several, the Aryan, Semitic, Georgian, and others in Caucasia. Why should they not have developed two in Africa, the Hamitic and Tubu? Elsewhere I have endeavoured to account for this remarkable phenomenon of specific diversity of speech within the same ethnical group.[1] Here it will suffice to note the fact, and if the no-gender character of Tubu be urged as a difficulty, the reply is twofold. First, no-gender languages occur also in other Caucasic groups, as in Basque, Georgian, Lesghian; secondly, although gender has not been developed in Tubu, nevertheless it contains the raw material, so to say, which has been elaborated into a system by the more cultured Hamitic peoples. After admitting that, but for the absence of this feature, there would be no scruple (*Bedenken*) in affiliating Tubu to the Hamitic order, Dr. Nachtigal adds: "Tubu also certainly seems to possess the elements by which gender is indicated in the Hamitic—*o* and *p* for the masculine, *t* for the feminine, as in *o-mri*, man; *mi*, son, by the side of *ådi*, woman; *dô*, daughter; *dê*, mother; *edi*, female" (p. 200). Here *d* of course answers to *t*, the universal mark of the feminine gender in Hamitic, and in the Berber group often both prefixed and postfixed, as in *akli*, negro; *taklit*, negress.

Room must therefore be made in Lepsius's scheme for a third linguistic family, the honour of having determined which belongs to Dr. Nachtigal. This Tubu family must be assumed to have been independently evolved in remote ages by the Garamantes, ancestors of the Tubu nomads, during long isolation in Kafara, Kawár, Tibesti, and the other oases of the eastern Sahara and Fezzan. Lastly, the Tubu themselves must be absolutely separated from the Negro ethnical connection, and grouped with the Hamites in the Mediterranean division of mankind.

A. H. KEANE

OUR BOOK SHELF

The Electric Lighting Act, 1882, *the Acts incorporated therewith, the Board of Trade Rules, together with numerous Notes and Cases*. By Clement Higgins, M.A., Recorder of Birkenhead, and E. W. W. Edwards, B.A., Barrister-at Law. (London: W. Clowes and Sons, 1883.)

PRACTICAL electricians unversed in law, and lawyers unversed in the practical applications of electricity, will

[1] See Appendix to my "Asia" (Stanford Series), p. 695.

find much useful matter in this volume. The authors are thoroughly competent to deal with the legal aspect of the case, whilst their judicious comments show that they appreciate at least many of the technical difficulties necessarily presented by the subject. The contents deal with the various sections of the Electric Lighting Act, adding copious notes and comments, and references to legal precedents and decisions. Quotations are given from the evidence collected by the Select Committee on Electric Lighting, and from the Rules and Regulations recommended by the Society of Telegraph Engineers and Electricians concerning the prevention of fire-risks. One or two minor slips in the science are to be regretted, as for example where the authors state that a current of unit strength will decompose ·09378 grammes of water per second. It is a pity, moreover, that they have departed from customary usage in speaking of the "strength" of a current as its "intensity." That term has been and is still so much abused, that so long as it is liable to mislead its use should be avoided. One of the authors describes himself as "Fellow of the Physical Society of London." We were not aware that the Physical Society of London recognised any such grade amongst its members.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Ben Nevis Observatory

IN NATURE, vol. xxvii. p. 399, there is among its notes of scientific intelligence, a paragraph mentioning that at a public meeting in Glasgow last week, called at the suggestion of Sir William Thomson and Mr. John Burns of Castle Wemyss, it was agreed to collect money for a permanent observatory on Ben Nevis.

As NATURE has always kindly encouraged this project of the Scotch Meteorological Society, perhaps you will permit me, as Chairman of the Society's Council, to add a little to this brief notice.

A requisition was presented to the Lord Provost of Glasgow, which was signed, not only by the eminent physicist and the extensive ship-owner mentioned in your notice, but also by Dr. Grant of the Glasgow Observatory, suggesting that a meeting of the merchants and ship-owners should be called to aid the Society in raising the necessary funds.

The Lord Provost in compliance called a meeting for the the 14th inst., which was well attended, and at which very able speeches were made, not only by the three requisitionists, but by the Lord Provost and by other influential citizens. The result of the meeting was a resolution expressing approval of the Society's proposal, and appointing a Committee to obtain subscriptions in aid of it.

It is expected that the amount of the funds required will be obtained from a community so wealthy and so public-spirited as that of Glasgow. But if we are mistaken in this, the Society's Council intend to appeal to other communities also for help, being resolved to resort to every legitimate means of attaining an object allowed on all hands to be of national importance.

The Council began with Glasgow, not only because it is the richest community in Scotland, but because the Scotch Meteorological Society *originated* there. The late Sir John G. Forbes of Pitsligo, and I, being both of us interested in meteorology, applied to the British Association for the Advancement of Science, when it met in Glasgow in September, 1855, under the presidency of the Duke of Argyll, to see whether it would approve of the formation of a Meteorological Society for Scotland. The result of our application was the following resolution by the General Council:—

"*Resolved, that the British Association express their satisfaction at the proposed establishment of a Scotch Meteorological Society, and their willingness to afford the Society any assistance which can be yielded by the establishment of the Association at Kew.*

"*That a letter to this effect be addressed to the Meteorological Society by the General Secretary.*"

On the basis of this testimonial by so influential a body, Sir John Forbes and I proceeded at once with the organisation of a Society, the Duke of Argyll being our first President, and assisting us greatly by his patronage.

When the Society resolved on attempting the formidable undertaking of establishing an observatory on Ben Nevis, at a cost of at least 5000*l.*, the first movement for funds was made among its own members and friends, the result of which was a promise of 1400*l.* provided the full sum of 5000*l.* was raised. In order to be enabled to fulfil this condition, the Society's Council not unnaturally went first to the town where it originated, and which more than any other town would be supposed to take an interest in the Society and its operations.

There was this further reason: that the Observatory being intended to be on the west coast, its proximity to Glasgow would add to that interest, and the more so as, on account of the vast shipping and commerce of the Firth of Clyde, no district of Scotland could be so deeply concerned in obtaining additional data for storm warnings.

The British Association, by way of encouraging the formation of the Meteorological Society, expressed in the resolution before quoted a willingness to afford to it assistance from its establishment at Kew.

This promise, unfortunately, the Association was unable to fulfil. But this disappointment to our Society has now been so far compensated by a handsome donation of 100*l.* towards the Ben Nevis fund from Dr. Siemens, the present President of the Association.

The Scotch Meteorological Society is one out of many proofs of the usefulness of the British Association in encouraging researches in particular branches of science, and the recent recognition of the Society's work in this Ben Nevis enterprise by so eminent a man as the present President of the Association is very gratifying to the Council. DAVID MILNE HOME

Milne Graden, Coldstream, February 26

Indian Archegosaurus

THE skull and part of the vertebral column of a large labyrinthodont, allied to *Archegosaurus*, was obtained in 1864 from the Bijori-group of the trias-jura of India, and presented to the Asiatic Society of Bengal. It was soon after sent to England for determination. All traces of this unique and important specimen, which should now belong to the Government of India, are now lost, and I write in the hope that some of your readers may be able to afford us a clue to its present position. The specimen can hardly have been mislaid, as it is some two feet in length. RICHARD LYDEKKER

The Lodge, Harpenden, Herts, February 21

The "Vampire Bat"

KINDLY permit me to ask for a further explanation from Mr. Geo. J. Romanes about the vampire bat, in regard to which he says in his criticism of "Zoological Sketches" (Oswald): "Mr. Bates says (I presume it is a clerical error giving Mr. Belt as the authority) the vampire, however, is the most harmless of all bats." Yet he, Mr. Bates, would lead us to believe that a species of the same genus, Phyllostoma, is a blood-sucker, and had even attacked himself (see p. 91 of the fifth edition of his "Naturalist on the Amazon").

Is there a species of Phyllostoma that lives on fruits, the vampire, and another species of the same genus that Mr. Bates calls "the little grey blood-sucking Phyllostoma," that may possibly attack human beings?

The late Chas. Waterton seems to have had no doubt that the vampire attacks persons asleep, and gives an instance.

The common name vampire may not be in South America confined to the species *Phyllostoma spectrum*. Mr. Romanes' remarks would lead one to believe that he considered there was no species of bat that attacked human beings.

THOS. WORKMAN

4, Bedford Street, Belfast, February 15

DR. ROMANES, in criticising a book ("Zoological Sketches"), in NATURE, vol. xxvii. p. 333, says: "The writer speaks of

vampire bats as those which suck the blood of sleeping persons, whereas the truth is, as Belt has remarked, 'the vampire is the most harmless of bats.'"

In Charles Darwin's "Voyage of the *Beagle*," we find an account of a vampire bat (*Desmodus d'orbignyi*) sucking the withers of horses during repose. We also have Charles Waterton's most circumstantial account of the sucking of the blood of human sleepers. Waterton says there are two species, only one of which attacks man. The Rev. J. G. Wood tells us in his notes to "Waterton's Wanderings" that the bat is *Vampirus spectrum*, on what authority he does not say, but quotes C. Kingsley in confirmation of the blood-sucking habit. Again, Prof. Mivart has an article in the *Popular Science Review* for July, 1876, on bats, in which he not only quotes Darwin's account, but speaks of the modification of the teeth and stomach of *Desmodus* as specially suited to this habit. What I wish to ask in all humility, as a mere onlooker, is, How are we to reconcile the above statement with all this authority?

94, Jacob Street, Liverpool, February 12 A. W. AUDEN

I INADVERTENTLY wrote the name of Belt while quoting from the work of Bates. The answer to the question which your correspondents ask is sufficiently simple, and has, in fact, been furnished by one of them, viz., that while the vampire bat itself does not suck blood, the name is popularly extended to other kinds of bats which do. These other kinds—or at any rate some of them—belong indeed to the same sub-family as the vampire (viz., genera *Phyllostoma* and *Desmodus*); but that the large and repulsive-looking vampire is innocent of the habit in question may briefly be made evident by citing again, and a little more fully, the authority of Mr. Bates, who writes: "The vampire was here by far the most abundant of the family of leaf-nosed bats. . . . . No wonder that imaginative people have inferred diabolical instincts on the part of so ugly an animal. The vampire, however, is the most harmless of bats, and its inoffensive character is well known to residents on the banks of the Amazons" ("Naturalist on the Amazon," p. 337).[1] Again, Mr. G. E. Dobson writes: "This species (*Vampirus spectrum*), believed by the older naturalists to be thoroughly sanguivorous in its habits, and named accordingly by Geoffroy, has been shown by the observations of modern travellers to be mainly frugivorous, and is considered by the inhabitants of the countries in which it is found perfectly harmless" ("Catalogue of the Chiroptera, &c." p. 471).

In conclusion, I cannot quite understand why my remarks should have led any one to believe, as one of your correspondents says, that I consider there is no species of bat which attacks human beings. I stated that the author whom I was reviewing was wrong in speaking "of vampire bats as those which suck the blood of sleeping persons," a statement which appears to me plainly enough to imply that there are certain other bats which do suck the blood of sleeping persons.

GEORGE J. ROMANES

Hovering (? Poising) of Birds

LET me entreat the Duke of Argyll not to confuse the issue between us. I made bold to ask his Grace to draw a diagram showing by what balance of forces he thought a bird could be sustained in mid-air, motionless on motionless wings, in a perfectly horizontal wind; and he refers me to a beautiful drawing of a kestrel hovering, *with fluttering wings, in still air.* (See note at foot of page 161 of the "Reign of Law," 5th edition, 1868: "Mr. Wolf's illustration of a kestrel hovering shows accurately the position of the bird when the action is performed in still air.")

This is quite beside the mark. The problem to be solved is not, How does a bird remain at rest in mid-air on fluttering wings? That question is admirably answered in the "Reign of Law" (p. 160). But the problem before us—the same that was discussed in NATURE in 1873-74—is simply this, How does a bird remain at rest in mid-air on perfectly motionless wings?

Does the Duke deny that this ever takes place? Has he forgotten the letters of Prof. Guthrie and Major Herschel (NATURE, vol. viii. pp. 86 and 324) in which the phenomenon was so graphically described? The Duke himself says (NATURE, vol. x. p. 262), "that under certain conditions of strength of air-current a kestrel can maintain the hovering position with no visible muscular motion whatever;" and compares the action to that of a rope-dancer "standing still in some tiptoe attitude." At that time he appears to have recognised the peculiar features of motionless hovering; but now he denies that he has ever "seen a kestrel's wings motionless when hovering," except for a moment or two, and even then he "could detect the quivering of the quills."

I am really at a loss to know whether the Duke maintains his former position; or whether by shifting his ground he admits that it is untenable; or, lastly, whether he has not partly misapprehended the problem under discussion.

In instancing the "hovering of a boy's kite" the Duke curiously parodies the mistake which he made in his last letter, which required for its correction the tilting of gravity through a certain angle. So here, when he says, "the element of weight is here represented by the string, held at the surface of the ground," he forgets the all-important angle between the direction of gravity and the direction of the string at its point of attachment to the kite.

HUBERT AIRY

February 26

HAVING all my life given some attention to the flight of birds, I may mention that I have frequently noticed both hawks and gulls stationary in the air, without flapping, for five or six seconds over the Cornish cliffs when the wind has been blowing off the sea, but never under the circumstances mentioned by Dr. Rae. I totally fail to see why Mr. Airy should be, as the Duke of Argyll states (NATURE, vol. xxvii. p. 387), "mistaken in his description of the facts," it having been plain throughout that Mr. Airy employs the term "hovering" as equivalent to "hanging in motionless poise." Mr. Wolf's kestrel in the "Reign of Law," p. 160, is shown as moving its wings through an angle of about 30°.

Although I believe there is nothing in the etymology of the word "hover" which implies movement, yet its similarity to such words as "quiver," "shiver," &c., may have caused the idea of movement to be associated with it; but whether this be a "disease of language" or not, Mr. Airy seems to have most accurately described what is surely not an uncommon fact of observation.

W. CLEMENT LEY

The Auroral "Meteoric Phenomena" of November 17, 1882

IF Dr. Groneman has established the fact that the spindle-shaped beam from every point of observation appeared moving in a straight line, that is an important point gained; but I fail to gather from his letter on p. 388 that there is clear evidence of this. He cites S. H. Saxby as one observer in favour of this, but his description appears to me very ambiguous. When he says, "Its trajectory was much flatter than that of the stars," what stars does he mean? If he means the stars at the same declination as that of the beam, viz. about 10° S., then a great circle undoubtedly would be flatter, but still more would a small circle having its centre at the magnetic pole. On the other hand, H. D. Taylor writing from near York describes the path of the beam as from south-east to south-west, thus making it a small circle curved in the wrong direction for an auroral arch.

It must be remembered that it is very difficult to judge whether a trajectory is a straight line when it covers a great extent in azimuth.

T. W. BACKHOUSE

Sunderland, February 26

IT is much to be desired that the increasing interest concerning this great phenomenon should supply the only way of obviating the paucity and incompleteness of observations, by having a meeting of observers and advanced nature-students either at London or Bristol. The Utrecht observation says: "When this arch had obtained the length of 90° (which lasted only a few seconds), a separation was made in the middle of its length," &c. I think this accounts for many of the discrepancies.

M. Groneman writes: "The Dutch observations confirm the English, only the phenomenon seems to have been of greater apparent size and therefore nearer." I used to think this for the same reason he gives, but I now think it probable that it was further from the earth when it first approached.

From Bordeaux I learn the sky was cloudy, but the aurora was well seen from Rome, Spezia, and Florence, and I have hopes of observations from the north of Italy.

The logical position is that we must lay aside all preconceived

opinions; that we must be prepared to receive fresh ideas from our new views of the action of intense heat on gases and meteorites.

I have only one point to add to my own observation (at two, not ten, minutes past six, as misprinted), that the object, when nearest, presented through its length (but rather below than above) a remarkable "*boiling*" appearance (as seeds in a capsule), while the edges appeared smooth and quiet.

The Rookery, Ramsbury, February 20 ALFRED BATSON

Aurora

A NEWSPAPER paragraph that has come under my notice describes "a strange phenomenon" seen at Brixham on Thursday morning at 1.30—the 15th instant is to be inferred from the date of the paper. It would seem to have been an aurora—yet another example of exceptional auroral activity attendant on the passage of large sun-spots, as there was a spot of importance approaching the sun's central meridian at the time. Any definite information concerning this particular manifestation, or indeed aurora generally near the date in question, appears worthy of a place in your journal. The sun-spot maximum is passing—perhaps past—and such opportunities should not be lost.

February 24 F. B. E.

DIURNAL VARIATION OF THE VELOCITY OF THE WIND ON THE OPEN SEA, AND NEAR AND ON LAND [1]

DURING the three-and-a-half years' cruise of the *Challenger*, ending with May, 1876, observations of the force and direction of the wind were made on 1202 days, at least twelve times each day, of which 650 days were on the open sea, and 552 days near land. The observations of force were made on Beaufort's Scale, (0—12) being the scale of wind-force observed at sea. The five oceans have been examined separately, viz., the North and South Atlantic, the North and South Pacific, and the Southern Ocean, and thereafter the results grouped together. The mean diurnal periodicity in the force of the wind on the open sea and near land respectively is shown on Fig. 1, where the figures on the left are Beaufort's Scale, and those on the right their equivalents in miles per hour. The solid line represents the mean force on the opea sea, and the dotted line the mean force near land.

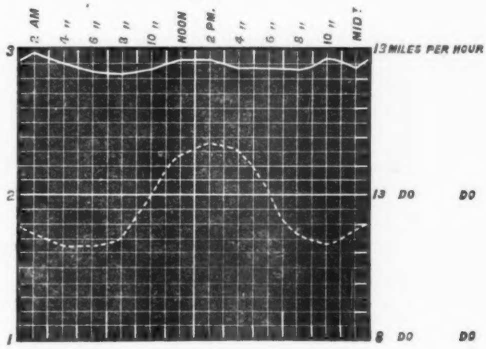
As regards the open sea, it is seen that the diurnal variation is exceedingly small, showing only two faintly-marked maxima about midday and 2 a.m. respectively. On examining, however, the separate means for the five oceans, no uniform agreement whatever is observable among their curves. The slight variations which are met with are different in each case, not one of the maxima or minima being repeated at the same hours in more than two of the five oceans. It follows, therefore, that the force of the winds on the open sea is subject to no distinct and uniform diurnal variation. The difference between the hour of least and that of greatest mean force is less than a mile per hour.

Quite different is it with the winds encountered by the *Challenger* near land, where the observations of the force of the wind give a curve as pronouncedly marked as the ordinary diurnal curve of temperature. The minimum occurs at 2 to 4 a.m., and the maximum from noon to 4 p.m., the absolute highest being at 2 p.m. The curve constructed for each of the five oceans, from the observations near land, gives one and the same result, viz., a curve closely agreeing with the curve of diurnal temperature.

The 650 daily observations on the open sea give a mean velocity of $17\frac{1}{2}$ miles per hour, but the 552 near land give a velocity of only $12\frac{1}{2}$ miles per hour. The difference is greatest at 4 a.m., when it amounts to upwards of 6 miles an hour, but is diminished as the temperature rises, till at 2 p.m. it is less than 3 miles an hour.

At Mauritius, which is situated within the south-east trades, the minimum velocity of the wind is 9·7 miles per hour, occurring from 2 to 3 a.m., from which hour it rises to the maximum 18·5 miles from 1 to 2 p.m., the influence of the sun being thus to double the wind's velocity. At Batavia, situated in a region where the mean barometric gradient is much smaller, the differences are still more decided. From 1 to 6 a.m., 85 per cent. of the whole of the observations are calms, whereas from noon to 2 p.m only 1 per cent. are calms. In all months the minimum velocity occurs in the early morning, when the temperature is lowest, and the maximum from 1 to 3 p.m., when the temperature is highest. At Coimbra, the mean maximum hourly velocity in summer is five times greater than the minimum velocity, whereas in winter it is only about a half more. At Valencia, in the south-west of Ireland, one of the stormiest situations in western Europe, the three summer months of 1878 gave a mean hourly velocity of 13·3 miles per hour, the minimum oscillating from 10 to 11 miles an hour from 9 p.m. to 6 a.m., and the maximum exceeding 16 miles an hour from 11 a.m. to 5 p.m. The absolutely lowest hourly mean was 10 miles at 11 p.m., and the highest 18 miles at 1 p.m., the velocity about midday being thus nearly double that of the night. The results of observations at many other places might be added to these, including those published by Wild, Hann, Köppen, Hamberg, and others, which go to establish the fact that the curves of the diurnal variation of the velocity of the wind generally conform to the diurnal curves of temperature.

FIG I.



The curves of the diurnal variation are most strongly marked during the hottest months. The maximum velocity occurs at 1 p.m., or shortly thereafter, being thus before the maximum temperature of the day (occurring therefore at the time when insolation is strongest); and the minimum in the early morning, when the temperature falls to the lowest, or when the effects of terrestrial radiation are at the maximum. The rule appears to hold good with all winds, whatever be their direction, as shown by Hamberg. The exceptions to this rule are so few, and of such a nature, that they are in all probability attributable to causes more or less strictly local.

With respect to cloud, Hann has pointed out that for a number of places the mean maximum hourly velocity is 102 per cent. above that of the minimum with clear skies; 77 per cent. with skies half covered with clouds; and 50 per cent. with skies wholly covered. At Vienna, however, these rates of increase are, for clear skies, 101, and half-covered skies, 66 per cent., whereas when the sky is overcast the variation becomes irregular and but faintly marked. Hann has also examined the Vienna observations of the wind on those days when the velocity

[1] Part of this article is abridged from a forthcoming volume of the "Reports" of H.M.S. *Challenger*, by permission of the Lords Commissioners of H.M. Treasury.

did not exceed 30 kilometres per hour and on the days when this rate was exceeded, and finds the diurnal periodicity well marked with light and moderate winds, but irregularly and only slightly marked with strong winds and stormy weather.

In inquiring into the remarkable facts regarding the variation in the diurnal velocity of the wind observed in all climates, attention is first drawn to the two curves of Fig. 1, showing the observations of wind-force made on board the *Challenger* during the cruise. As regards the open sea, the diurnal curve shows practically no variation. The whole of the observations of the surface temperature of the North Atlantic made by the *Challenger* have been discussed, with the result that the daily range is only $0^{\circ}\cdot7$. Hence the statement may be regarded as substantially correct, that over the ocean the atmosphere rests on a floor the temperature of which is all but constant day and night; and, so far as concerns the generation of ascending aërial currents from a heated surface, practically constant.

On approaching the land, however, the daily range of the temperature of the air over the sea becomes materially augmented, the daily range being $4^{\circ}\cdot3$, and, as all observation shows, the temperature over land still more so. Now, bearing in mind that the temperature has risen above its daily mean at 10 a.m., and fallen below it at 10 p.m., an examination of the curve of velocity near land in Fig. 1 reveals the fact that the increase in the diurnal velocity of the wind is entirely restricted to those hours of the day when the temperature is above the daily mean, and the maximum velocity is reached at the hour when insolation, or the sun's heating power, is strongest. The phenomenon of the diurnal variation in the wind's velocity is thus associated in the closest manner with the temperature of the surface on which the air rests. Where there is practically no variation, as in the temperature of the surface of the sea, there is no variation in the velocity; but where, as on land, the temperature of the air has a strongly-marked daily period, the wind-force also is strongly marked, and the increase rises and falls with the degree of insolation on the surface. Further, the velocity increases, not with the increase in the temperature of the air, but with the heating of the surface; in other words, with the conditions on which ascending aërial currents depend.

It is also to be observed, as regards the curves of the five oceans, that they show in each case and at all hours of the day a greater velocity of the wind on the open sea than near land.

The following are the mean and extreme hourly velocities, in miles per hour, for the five oceans:—

	North Atlantic.	South Atlantic.	North Pacific.	South Pacific.	Southern Ocean.
	Miles.	Miles.	Miles.	Miles.	Miles.
Mean hourly velocity on open sea	18·0	18·1	14·5	16·2	23·5
Mean hourly velocity near land	15·0	14·7	9·6	11·0	17·6
Difference	3·0	3·4	4·9	5·2	5·9
Highest mean hourly velocity near land	17·0	16·4	11·6	13·7	20·8
Lowest mean hourly velocity near land	13·1	13·0	10·0	9·3	14·3
Diurnal variation near land	3·9	3·4	1·6	4·4	6·5

Thus the winds are lightest on the North Pacific, and strongest on the Southern Ocean, and these oceans show respectively the least and the greatest diurnal variation in the force of the wind on nearing land.

From the number and character of the two sets of observations, it may be assumed, without risk of error, that the open-sea and the near-land winds, summarised and represented in Fig. 1, were atmospheric movements resulting from mean barometric gradients substantially equal to each other. From the above table it is seen that in each of the oceans the mean velocity near land is less than that on the open sea, the two extremes being the North Atlantic, with a difference of 3·0 miles, and the Southern Ocean with a difference of 5·9 miles; and that even the maximum velocity during the day is always less than the velocity on the open sea. The slight rise in the near-land curve during night is probably wholly caused by the land-breezes felt on board the *Challenger* when near land. In strictly inland places, tolerably well situated for making observations of the wind, this feature does not appear in the curve, and there the velocity falls to the diurnal minimum during the period of lowest temperature, or when the effects of terrestrial radiation are most felt on the surface of the ground.

From these results it follows that, so far as concerns any direct influence on the air itself, considered apart from the floor or surface on which it rests, solar and terrestrial radiation do not exercise any influence in causing the diurnal increase of the velocity of the wind with the increase of the temperature of the air; or if there be any influence at all, such influence is altogether insignificant, as the observations of the *Challenger* on the five great oceans of the globe conclusively prove. The same observations show that on nearing land the wind is everywhere greatly reduced in force, the retardation being due chiefly to friction, and to the viscosity and inertia of the air in relation to the obstructions offered by the land to the onward course of the wind. The retardation is greatest when the daily temperature is at the minimum, and it is particularly to be noted that though the temperature rises considerably, yet no marked increase in the velocity sets in till about 9 a.m., when the temperature has begun to rise above the daily mean. From this time the increase is rapid. The maximum velocity is reached immediately after the time of strongest insolation, and falls a little, but only a little, during the next three to five hours, according to season, latitude, and position. The velocity is low during the hours when the temperature is lower than the daily mean, and the least velocity occurs early in the morning. Even the maximum near land falls considerably short of the velocity which is steadily maintained over the open sea by night as well as by day.

The period of the day when the wind's velocity is increased is thus practically limited to the time when the temperature is above the daily mean, and the surface superheated, and the influence of this higher temperature is to counteract to some extent the retardation of the wind's velocity resulting from the causes already stated. The results show that the increase in the diurnal velocity of the wind is due to the superheating of the surface of the ground, and to the ascensional movement of the air consequent thereon, which tend to reduce the effects of friction and viscosity of the air. It is of importance in this connection to keep in view the fact, shown by hourly observations made at the instance of the Marquis of Tweeddale in 1867 on the temperature of the soil and air, that in cloudy weather a temperature much higher than that of the air near the ground was radiated from the clouds down upon the earth's surface (*Journal Scottish Meteorological Society*, vol. ii. p. 280). Hence in cloudy weather the superheating of the surface-layer of the ground will often take place, the greatest degree of heating being under an overcast sky, where the cloud-covering is of no great thickness, and the temperature of the clouds themselves is much higher than that of the surface of the earth. On the other hand, little or rather no heating will take place, when the cloud-screen which overspreads the sky is of great thickness, and the

temperature of the clouds is not greater than that of the surface; and when the temperature of the cloud-screen is lower than that of the surface, the temperature of the latter will fall. It is scarcely necessary to remark that in discussing the influence of cloud on the diurnal periodicity of the wind's velocity, only such means are of real value as are calculated from a very large number of observations.

During the night, when terrestrial radiation is proceeding, the temperature of the surface falls greatly, and instead of an ascensional movement in the lowermost stratum of the air, there is, on the contrary, a tendency towards, and, if the wind be light, an actual descensional movement down the slopes of the land. The effects of friction being thus intensified, the velocity of the wind falls to the daily minimum during these hours.

ALEXANDER BUCHAN

EPHEMERIS OF THE GREAT COMET, b 1882

(Communicated by Vice-Admiral Rowan, Superintendent U.S. Naval Observatory)[1]

GREENWICH MEAN NOON

1883	R.A. h.	m	s.	Decl. °	′	″	Log. r.	Log. Δ.
Feb. 10·0,	6	0	37·8	−19	41	17	0·48137	0·38891
14·0,	5	57	40·4	18	40	13	0·48909	0·40520
18·0,	5	55	19·7	17	41	17	0·49669	0·42132
22·0,	5	53	32·7	16	44	35	0·50413	0·43723
26·0,	5	52	14·7	15	50	14	0·51133	0·45282
March 2·0,	5	51	24·4	14	58	16	0·51841	0·46817
6·0,	5	50	58·7	14	8	43	0·52532	0·48322
10·0,	5	50	54·8	13	21	37	0·53200	0·49790
14·0,	5	51	12·3	12	37	0	0·53861	0·51231
18·0,	5	51	47·9	11	54	52	0·54508	0·52635
22·0,	5	52	39·5	11	15	10	0·55135	0·53995
26·0,	5	53	46·1	10	37	56	0·55751	0·55316
30·0,	5	55	6·1	10	3	6	0·56354	0·56594
April 3·0,	5	56	38·1	9	30	34	0·56944	0·57828
7·0,	5	58	20·9	9	0	19	0·57520	0·59015
11·0,	6	0	13·9	−8	32	21	0·58090	0·60158

Note.—In the published elements ϕ should be $89° 13' 42''·70$ instead of $89° 7' 42''·70$.

Washington, February 10

E. FRISBY,
Prof. Math., U.S.N.

ILLUSTRATIONS OF NEW OR RARE ANIMALS IN THE ZOOLOGICAL SOCIETY'S LIVING COLLECTION[2]

XI.

29. THE CAPE SEA-LION (*Otaria pusilla*).—It is a singular and as yet unexplained fact in geographical distribution, that while the Sea-lions amongst Mammals and the Albatrosses amongst Birds are confined to the South Atlantic Ocean, both these groups reach up to high northern latitudes in the Pacific. In the Atlantic, no Albatross is seen "north of the line," whereas these birds are familiar objects on the coasts of both California and Japan. No Sea-lion is met with in the Atlantic until we get to the Cape on one side and the La Plata on the other, but these animals are well-known objects at San Francisco, and the great supply of their much-valued furs comes from the far northern territory of Alaska.

The Sea-lion first became an inhabitant of our Zoological Gardens, and thus known to Europe in a living state, in 1866, when a French seaman, François Lecomte, brought to this country an example of the Patagonian species (*Otaria jubata*), and exhibited it to the public. The remarkable form of this animal, its extreme docility, and its agile movements attracted great attention, and led to its acquisition by the Zoological Society, in whose Gardens it quickly became an established favourite. Upon the death of this individual in the autumn of the same year, the Council of the Society determined to send out Lecomte, who had entered their service in charge of it, to the Falkland Islands, in order to obtain other specimens. Lecomte returned to this country in August, 1867, but owing to various unforeseen circumstances only succeeded in landing alive one of the four Sea-lions with which he had started from Port Stanley. This animal, young and small on its arrival, throve well under Lecomte's careful management, and soon supplied the void occasioned by the death of the original specimen. Like its predecessor, it exhibits extraordinary agility in the water, and catches the fishes thrown to it for food both above and below the surface with unerring aim.

Four years subsequently, in 1871, the Society received from Sir Henry Barkly, then Governor of the Cape Colony, a present of a young specimen of the Cape Sea-lion, of which we now give an illustration (Fig. 29). Like its Patagonian relative, the Cape Sea-lion is a female, and although quite adult, does not attain the dimensions of the male sex of these animals In general appearance, shape, and form, the two species are very similar, and present little obvious differences to the casual observer, except that the ear-lobe is longer in the Cape animal. To the two females has recently been added a young male of the Patagonian form, and the three individuals now live together in the narrow limits of their basin in the greatest harmony, forming one of the most attractive groups in the Regent's Park Gardens. Little has been recorded of the mode of life of the Sea-lion in a state of nature, but Mr. E. L. Layard in his "Catalogue of the South African Museum," tells us that it "is abundant along the whole of the coasts of the colony, and has given its name to numerous bays, islands, and capes, of which 'Robben' Islands near Cape Town is perhaps the best known.

"It resorts to these places in great numbers for breeding purposes, and is sought for and slain for the sake of its fur and oil. The male is said to be maned, and to much exceed the female in size, but though double the market value of the skin has been offered by the Museum for a skin of the male of this common animal, as it is not *the custom* of the sealers to take the skin off, leaving in the head and feet, we have been unable to procure one."

As regards the habits of some of the other members of this genus, which are of the most extraordinary character, we have now ample details concerning the North Pacific species in a very interesting and well illustrated work prepared by Mr. Henry W. Elliott on the Seal Islands of Alaska and their productions.[1]

Soon after the Sea-lions were established in the Zoological Gardens in this country, specimens of these animals were obtained by the principal Gardens on the Continent, and basins built for the exhibition of their aquatic evolutions. But the examples on the Continent, as well as those in the Aquarium at Brighton, all belong to one of the North Pacific species of Sea-lion (*Otaria californiana*), which is found in enormous multitudes upon the Pacific coast. Of the South African species now figured, the example in our Zoological Society's Gardens is the only one yet brought alive to Europe.

30. BLANFORD'S SHEEP (*Ovis blanfordi*).—Every high mountain-tract in Northern and Central Asia appears to be occupied by a distinct form of Wild Sheep (*Ovis*), while single outliers of the same genus are found far to the west in Sardinia and to the east in North America. Some of these animals, such as the celebrated "Ammon" of Ladakh (*Ovis hodgsoni*) and the Snow-sheep of Kamschatka (*O. nivicola*), attain a magnificent size and

[1] Computed from elements (NATURE, vol. xxvii. p. 225) and reduced to the mean equinox 1883·0.

[2] Continued from p. 154.

[1] A Monograph of the Seal Islands of Alaska. By Henry W. Elliott Reprinted, with additions, from the Report of the Fishery Industries of th Tenth Census. 4to. Washington, 1882.

development, whilst others, like the Sardinian species (*Ovis musimon*), are more nearly of the dimensions of the ordinary domestic animal.

The Wild Sheep best known to the sportsmen of British India is the "Koch" or "Gudd" of the Punjaub, also called the "Corial." The Corial frequents the

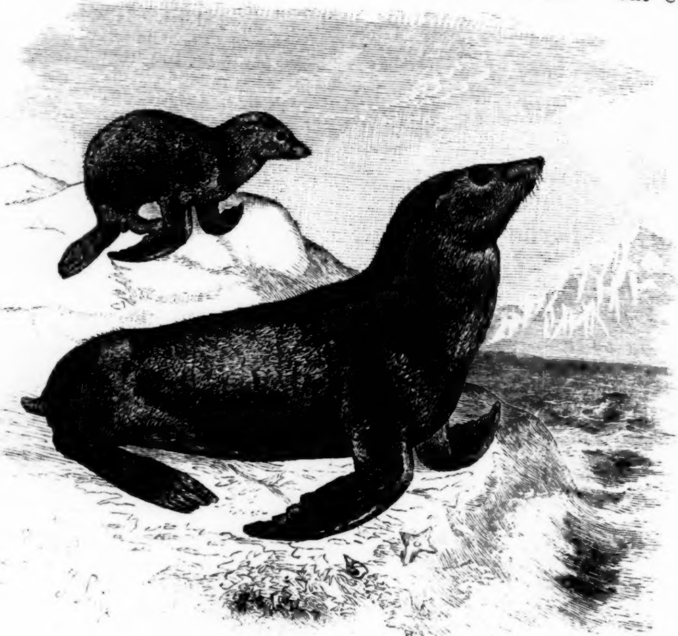


FIG. 29.—The Cape Sea-li n

FIG. 30.—Blanford's Sheep.

rocky and stony hills of the Punjaub, as also the Sulimani range on the other side of the Indus and the hills of Hazara and Peshawur. In these districts, Dr. Jerdon tells us, it occurs at very low elevations—from 800 to

2000 feet above the sea-level—and is capable of enduring great heat.

The Punjaub Sheep was introduced into the Zoological Society's series nearly thirty years ago, and has frequently bred in their menagerie. The adults of both sexes and the lambs, of which two are generally produced at a birth, are correctly figured in Wolf and Sclater's "Zoological Sketches" from specimens living in the Society's Gardens.

The recent extension of British influence into Khelat and Afghanistan has led to our acquaintance with the Wild Sheep of the higher ranges of these territories, which, although closely allied to that of the Punjaub, is perhaps distinct and entitled to specific separation. Such at least is the opinion of the Indian naturalist, Mr. A. O. Hume, who in 1877 described and figured the horns of this form, from a specimen received from Major Sandiman, under the name *Ovis blanfordi*, in honour of Mr. W. T. Blanford, a well-known Indian zoologist and geologist. Mr. Hume's example of Blanford's Sheep was obtained in the hills above the Bolan Pass. The specimen from which our drawing has been prepared (Fig. 30) was captured in Afghanistan during the recent campaign in that country, and presented to the Zoological Society by Capt. W. Cotton in February, 1881. It is a young male animal with the horns not yet fully developed, and has been placed in company with a female of the better-known Sheep of the Punjaub hills, with which, there is no doubt, it will readily cross.

31. THE UVÆAN PARRAKEET (*Nymphicus uvæensis*).—In the second volume of Capt. Cook's "Voyage towards the South Pole and round the World" will be found (at p. 110) a large, double, copper-plate engraving entitled a "View in the Island of New Caledonia," taken from a sketch prepared by Hodges, the artist of the expedition. The left-hand corner of this engraving contains a rude figure of a parrot with two feathers projecting from the summit of its head. This is doubtless

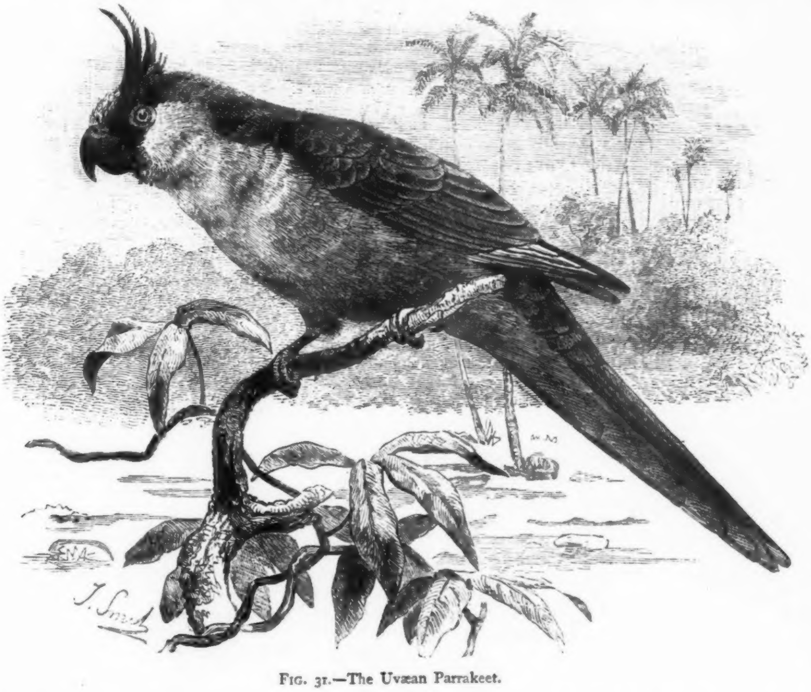


FIG. 31.—The Uvæan Parrakeet.

the first representation ever given of the celebrated "Horned Parrot" of New Caledonia, of which a single specimen was obtained by the great circumnavigator when the island itself was first discovered (in September, 1774), and brought home for the collection of Sir Joseph Banks.[1]

Since the time of Cook until recent days little more has been known of this singular parrot. In the posthumous works of Forster, who accompanied Cook as naturalist, it was described as "*Psittacus bisetis*," and Wagler, in 1832, made it the type of a new genus "*Nymphicus*." But specimens remained very scarce, and Dr. Finsch in his excellent history of the Parrot-tribe, published in 1868, tells us that it was then still one of the rarest of the whole family in the museums of Europe.

In 1879 however two living examples of this parrot were brought to London in a vessel coming from Sydney, and secured by the Zoological Society for its parrot-house. There was thus for the first time for those who do not wish to make a voyage to New Caledonia, an opportunity of seeing this lovely species in its full beauty. What, however, followed was still more singular. In April, last year, while the two Horned Parrots were still alive, there arrived in the London market a second pair of birds of the same peculiar structure, but presenting ample distinctions for their recognition by naturalists as a distinct species. These birds, it need hardly be said, were quickly secured for the Zoological Society's Aviary, so that the two forms might be exhibited side by side. At the same time was received a communication from Mr. E. L. Layard, H.B.M. Consul at Nouméa, in New Caledonia, a Fellow of the Zoological Society, and a well-known naturalist, describing the new species under the name *Nymphicus uvæensis* (see *P. Z. S.*, 1882, p. 408, Pl. XXVI.).

[1] See Latham's "Synopsis of Birds," vol. i. p. 248.

It would appear that the Uvæan Parrakeet, of which we now give an illustration (Fig. 31), taken from one of the Zoological Society's living specimens, is a kind of satellite of the New Caledonian Parrakeet, as is the small island of Uvéa, in which it is found, of the larger island of New Caledonia. Mr. Layard had a living pair of the Uvean bird for some time in his possession before he noticed their difference from the New Caledonian bird, of which he had regarded them as the immature form. But in the first place the crest of the two birds is totally different. In *Nymphicus cornutus* the crest is composed of two elongated feathers, which are black, faintly tinged with green, and broadly tipped with red. In *N. uvæensis*, as will be seen in our figure, the crest consists of a bunch of about six short, upturned, entirely green feathers, springing from the end of a small spot of red which occupies the centre of the forehead. In *N. cornutus* the two long crest-feathers rise from the centre of the broad red cap which covers the whole top of the head. Besides this difference the former bird does not present the broad orange nuchal collar which ornaments *N. cornutus*, and exhibits only the faintest trace of orange on the rump.

The small island of Uvéa, one of the Loyalty group, to which the new species is confined, consists, as Mr. Layard tells us, of a series of small islets joined together by a connecting reef with a lagoon in the centre. It is very singular that this distinct form should be found only in so restricted a locality, while its near relative, the "Horned Parrot" of Cook, appears to be distributed all over the large island of New Caledonia.

THE ELECTRIC LIGHT AT THE SAVOY THEATRE[1]

MR. D'OYLY CARTE, having determined to light the Savoy Theatre by the Swan incandescence electric light, intrusted the work of installation to Messrs. Siemens Brothers and Co. The theatre is lighted by no less than 1194 Swan lights of the improved form introduced by Mr. C. H. Gimingham, of the Swan United Electric Light Company. Of these 1194 electric lights, the auditorium is lighted by 150 lamps attached in groups of three, supported on threefold brackets projecting from the different tiers and balconies, each lamp being inclosed within a ground, or opaloid, shade, by which arrangement a soft and pleasant light is produced. These bracket lamp-holders have been designed and constructed by Messrs. Faraday and Son, of Berners Street, London.

Two hundred and twenty lamps are employed for the illumination of the numerous dressing-rooms, corridors, and passages belonging to the theatre, while no less than 824 Swan lamps are employed for the lighting of the stage.

The stage lights are distributed as follows:—

6	rows of	100	lamps each	above the stage ...	600
1	,,	60	,,	,, ,, ...	60
4	,,	14	,,	fixed upright	56
2	,,	18	,,	,, ...	36
5	,,	10	,,	ground lights ...	50
2	,,	11	,,	,, ...	22
					824

In addition to the above-mentioned lights within the theatre, there are eight pilot lights in the engine-room, which, being in the same circuit with some of the lights in the theatre, serve the purpose not only of illuminating the machinery, but also of indicating to the engineer in charge of the machines, by the changing of their illuminating power, when the lights in the building are turned up or down.

The lamps are at present worked in parallel circuit in six groups, five of which comprise 200 lamps each, and the sixth 202 lamps. The current of each group is produced by one of Messrs. Siemens Brothers and Co.'s W_1 alternate current machines, the field magnets of which are excited by a separate dynamo electric machine of the Siemens type, known as D_7. The machines and engines are fixed in a shed erected on a piece of waste land adjacent to the Victoria Embankment, the current being conveyed to the theatre by means of insulated cables laid underground.

The six alternate or W_1 machines are driven at a speed of 700 revolutions per minute, and the six exciting or D_7 machines at 1150 revolutions, by three steam-engines, that is to say, a portable 20-horse engine by Garrett, a 12-horse power portable by Marshall, and a 20-horse semi-portable engine by Robey, but the power actually utilised, as measured by a "von Hefner Alteneck" dynanometer, is between 120 and 130 horse-power. We must not, however, omit to state that, in addition to the six pairs of machines for working the 1202 incandescent lamps, there is also a D_2 Siemens dynamo machine for producing the powerful arc electric light suspended outside the theatre, and over the principal entrance in Beaufort Buildings, and that the power to drive this machine is included in the above-mentioned horse-power employed, as well as that necessary for driving the shunt machine used to charge the secondary batteries for the fairy lamps.

The most interesting feature, however, from a scientific point of view, of this most interesting installation, is the method by which the lights in all parts of the establishment are under control, for any of the series of lights can in an instant be turned up to their full power or gradually lowered to a dull red heat as easily as if they were gas lamps, by the simple turning of a small handle. There are six of these regulating handles, corresponding to the number of the machines and circuits—arranged side by side against the wall of a small room on the left of the stage, and each handle being a six-way switch, can, by throwing into its corresponding magnet-circuit greater or less resistance (according to its six stages), lessen or increase the strength of the current passing through the lamps by as many grades. The special interest of this part of the installation, however, is the fact that the turning down of the lights is accompanied by a corresponding saving of motive power in the engine, for the variable resistance which is controlled by the regulators is not thrown into the external or lamp circuit of the alternate current machines, but into the circuit by which their field magnets are excited.

The fittings of the lamps in the passages, staircases, &c., have, up to the present, been of a temporary nature, but, as the electric lighting has worked to the entire satisfaction of all concerned, these temporary fittings will now be replaced by permanent brackets, quite independent of the gas brackets.

All risk of fire is avoided by the leading wires being thoroughly insulated, and small pieces of lead wire being inserted into the circuit wherever a branch wire leaves the mains. These "safety-pieces" of lead are chosen of such size that they will melt before the conductors themselves become sufficiently heated to cause any danger, and by their melting the current is at once interrupted.

The small lamps worn by the fairies, and which have been specially made by the Swan United Electric Light Company, are rendered incandescent by the current produced from a small "secondary" battery, which is carried on the back like a small knapsack. These secondary batteries have been made by Messrs. Siemens Brothers and Co. on a new plan, and are charged by a shunt-wound Siemens' dynamo in the engine-shed. Each battery is provided with a switch, by means of which the light can be turned on or off by the wearer at pleasure.

The system of electric lighting has now been working

[1] Communicated.

at this theatre for about a year and a half without any accidents, and has proved to possess many advantages over gas as applied to the illumination of buildings of this description. Not the least amongst these are the total absence of heat and vitiated air in the house, and the length of time during which the decorations will retain their freshness and colour instead of becoming quickly faded and tarnished, as would be the case were the old system of gas adopted.

ON THE NATURE OF INHIBITION, AND THE ACTION OF DRUGS UPON IT

By inhibition we mean the arrest of the functions of a structure or organ, by the action upon it of another, while its power to execute those functions is still retained, and can be manifested as soon as the restraining power is removed.

It is thus distinguished from paralysis, in which the function is abolished, and not merely restrained.

Inhibition is one of the most perplexing problems in physiology, and we have at present no satisfactory hypothesis regarding it. It plays, however, such a very important part in pharmacology, that we cannot pass it over; and as it is through the action of drugs upon the various functions of the body that we have already arrived at a knowledge of inhibitory actions, which would otherwise have been impossible—as, in fact, pharmacology has here quite outstripped physiology—we are obliged to enter into some hypothetical considerations, in order to be able to form some kind of idea regarding the mode of action of many drugs.

Hypotheses serve as "pegs on which to hang facts," and by their aid the isolated facts which few memories could carry may be arranged, and their relation to each more readily perceived. A hypothesis serves also as a guide for further experiments, by which it may be either disproved or supported. Should facts be against it, so much the worse for the hypothesis; it must be discarded, and another tried in its place; but if facts agree with it we obtain a means of predicting phenomena, and make another step in knowledge. Like other useful things, hypotheses are not without danger, and sometimes do harm by satisfying people and stopping further inquiry. Thus Sultzer noticed the peculiar taste produced by the contact of two dissimilar metals with each other and with the tongue forty years before Galvani; but at that time the doctrine of vibrations was employed to explain all natural phenomena, and he concluded that some peculiar vibration occurred from the contact of the metals, which produced the peculiar sensation on the tongue. All the world were satisfied with the explanation, and thus a prominent fact slept in obscurity from the time of Sultzer to that of Galvani, no further attempts being made to determine the nature of the vibrations or the laws which governed them.[1] Yet in their proper place hypotheses are most useful, and but for the hypothesis that light, heat, and sound are due to waves, our knowledge of their phenomena would be much less than it is.

The cases of inhibition, as we may term them, which we meet with in the study of physics, are the production of complete silence by the interference of two sounds, and of darkness by the interference of two rays of light.

When two sounds or two rays of light are combined, so that the crests of the waves of which they consist coincide, the sound becomes louder and the light brighter. If they are thrown together, so that the crests of the waves in the one sound or ray coincide with the sinuses or hollows of the other, they completely counteract each other, and silence or darkness is produced.

When the waves are of different rhythms, the crests and hollows of the two sounds or rays, which at one time coincide, will gradually interfere, and again gradually coincide, so that rhythmical alternations of loud sound and silence, of bright light and darkness, are produced.

[1] Ree's Cyclopedia. Article "Galvanism."

A good example of interference or physical inhibition, and one that affords an illustration well suited to our purpose, is that of Newton's rings. When a lens of small curvature is placed on a plane surface of glass, a series of rings is observed, starting from the centre of the lens and passing concentrically outwards. If monochromatic light is used, such as pure yellow light, pure red light, &c., these rings are alternately bright and dark; but if white light is used, they appear as a number of circular bands of different rainbow colours. The cause of these rings is, that though the surface of the lens appears to the eye to be in contact with the plate of glass over a considerable area, it is not really so; a very fine film of air of varying thickness being interposed between them.

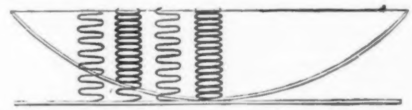


FIG. 1.—A very diagrammatic representation of interference in Newton's rings.

When a ray of light passes through the lens on to the glass, part of it is reflected back from the lower surface of the lens, and part of it from the upper surface of the glass plate. Between those two points there is a very minute film of air: *one ray has therefore to travel somewhat further than the other.* The distance which it has to travel is only through the extremely thin layer of air lying between the surface of the lens and the glass and back again; but this distance at some places is just sufficient to throw the waves in the one beam *half a wave-length* behind those in the other, and to produce darkness by their interference.

As we recede from the point of most complete contact between the lens and the glass, the thickness of air increases, the ray has somewhat further to travel, and the distance is then just sufficient to throw it *a whole wave-length* behind the other ray; no interference is produced, and we get a ring of bright light.

Further outwards the increased thickness of the film of air is again sufficient to throw one ray *a wave-length and a half* behind its fellow; interference is again produced, and darkness is the result.

With rays, then, of one colour, or of one wave-length, we get alternately light and darkness by interference.

But it is evident that the extra distance which the waves have to travel in order to produce interference will not be the same for long and short waves; and thus it is found that when white light, which contains rays of different wave-lengths, is used, the rings, instead of being alternately light and dark, are coloured.

The very distance which was sufficient to throw the red rays half a wave-length behind the other, and to produce interference, will throw, let us say, the violet rays a whole wave-length behind, and thus there will be no interference and *vice versâ;* the distance which causes interference of the violet rays does not cause interference of the red, and so on with other colours.

Thus the spaces which would have been perfectly dark when rays of pure red or pure violet, or more correctly ultra-violet, were used, would be filled up by the other if used together, and when white light is used, the various waves interfere at different places, and so we get a series of rainbow colours.

The extra distance which one beam has to travel in order to produce interference with another is *not absolute,* but relative to the wave-length. This relation differs for different wave-lengths, and therefore if the relative distances remain constant, the effect of the beams on each other will vary if their wave-lengths be changed.

It is obvious that if both the wave-lengths and the

distances they have to travel remain the same, the effect of the beams on each other will be altered by any change in their rate of travel such as would be effected by altering the media through which they pass.

This is a most important point in regard to the hypothesis of the causation of inhibition by interference of vibrations in the nervous system. It may therefore be useful to illustrate this further, and probably it could not be done better than by using, with a little modification, the example given by Sir J. Herschel in his article on Light in the Encyclopædia Metropolitana. "Let R be a reservoir of water, from which the channels A and B pro-

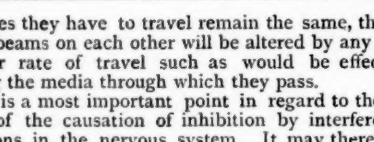


FIG. 2.—Diagram to illustrate Sir J. Herschel's observations on interference. Adapted from his article on "Absorption of Light," Phil. Mag. 1883, p. 405.

ceed, to join each other at P; they are supposed to be equal in every respect except that B is longer than A. If a wave from the reservoir enters the openings of A and B at the same time and travels at the same rate along them, the wave which passes through A will reach P sooner than the one which passes through B, so that the water at that point will be agitated by two waves in succession. But let the original cause of undulation be continually repeated so as to produce an indefinite series of equal and similar waves. Then if the difference of lengths of the two canals A and B be just equal to half the interval between the summits of two consecutive waves, it is evident that when the summit of any wave propagated along A has reached the point of intersection P, the depression between two consecutive summits (viz., that corresponding to the wave propagated along A and that of the wave immediately preceding it) will arrive at the intersection P by the course B. Thus in virtue of the wave along A the water will be raised as much above its natural level as it will be depressed below it by that along B. Its level will therefore be unchanged. Now as the wave propagated along A passes the intersection P, it subsides from its maximum by precisely the same gradations as that along B, passing it with equal velocity, rises from its minimum, so that the level will be preserved at the point of intersection P undisturbed so long as the original cause of undulation continues to act regularly.[1] So soon as it ceases, however, the last half-wave which runs along B will have no corresponding portion of a wave along A to interfere with, and will therefore create a single fluctuation at the point of concourse P."

It is obvious that if everything else remains the same, the effect which the waves have upon each other at P will be altered if the rate at which they travel is increased or diminished.

The more the speed is increased the less effect comparatively will the greater length of B have in retarding the wave which flows along it, so that its crest will no longer coincide with the trough or sinus of the waves in A, but will, on the contrary, coincide more nearly with the crest of one of the waves in A.

The more the speed is diminished, the more will the wave in B lag behind that in A, so that its crest, instead of coinciding with the trough between two crests of the waves from A will gradually come to coincide with the crest succeeding the trough, and thus double its magnitude instead of destroying it.

We see, then, that under the conditions we have supposed either increase or diminution in the rapidity of their transmission may convert the interference of waves into more or less complete coincidence, and the effect of the two waves may thus be doubled instead of neutralised by their superposition.

The alteration which is produced in the mutual effect of two waves by increase or diminution of their rate of transmission along channels of constant length supplies us I think with a test by which we may ascertain the truth of the hypothesis that inhibitory phenomena in the animal body are due to interference. For if it be true we ought to find that a nerve which produces inhibitory phenomena when excited under normal conditions will gradually lose this power when the rate of transmission along it is increased or diminished, as, for example, by the influence of heat or cold, and will gradually acquire an exactly contrary or stimulating action. This, I think, is shown to be the case by our experimental data so far as they go.

Several authors have pointed out the analogy between inhibitory phenomena in the animal body and the effects of interference of waves of light or sound. This has been done with special precision by Bernard[1] and Romanes.[2] The tendency to do away with the idea of distinct inhibitory centres is gradually spreading, but hitherto no attempt has been made to bring all the phenomena of inhibition under one general rule or to explain the mode in which they are affected by the action of drugs. The object of the present paper is to gather together some instances of inhibition which we find in the body, and to see whether by the theory of interference it is not possible to explain both the curiously perplexing exceptions which we meet with in physiological experiments, and the still more perplexing action of drugs on inhibitory phenomena.

One of the most striking examples of reflex action and of inhibition, is the effect of a slight touch or touches, and of firm pressure upon the palms of the hands, the soles of the feet, or the axillæ, and in some persons also the knees. In many persons a very slight touch or succession of touches upon these parts is sufficient to throw first the respiratory muscles, and then the whole body into violent convulsions. Indeed, it is stated that during the persecution of the Albigenses by Simon de Montfort, several people were tortured to death by tickling the soles of their feet with a feather. The stimulus here applied, and the consequences it produces, appear to be out of all proportion to one another; the stimulus being almost infinitesimal, and the consequences enormous.

In the case of Newton's rings it might be possible with much trouble to throw a different beam into such a condition that it would interfere with one of the beams in the rings and produce darkness, but in the rings a similar effect is produced in a very much simpler way by alteration of part of the same beam. A similar occurrence is to be observed in the inhibition of the reflex action on tickling.

By a very powerful effort of the will we may completely arrest the reflex movement which would otherwise occur, and allow the limb to remain perfectly passive. But the same effect is produced in a much simpler way by applying a firm pressure instead of a slight touch. The firm pressure neutralises the effect of the touch in regard to motion, and not only are no reflex convulsive actions produced, but no tendency whatever to them is felt.

But while the pressure has neutralised the tendency to motion, and has altered the character of the sensation, it has not neutralised sensation. On the contrary, it has rendered it more definite, so that one can distinguish with much greater certainty the particular point of the

[1] This actually happens in the harbour of Batsha, into which the waves pass from the open sea through two channels of unequal length.

[1] Bernard, La Chaleur Animale, Paris, 1876, p. 371.
[2] Romanes, Phil. Trans. 1877, p. 730.

surface which has been touched. Increased pressure has thus inhibited motion but increased sensation.

In a paper on "Inhibition, peripheral and central," which I wrote in the West Riding Asylum Reports in 1874, I tried to explain these phenomena in the following manner: "It appears to me to be in all probability due to there being two sets of ganglia in the cord itself, one motor and one inhibitory. The motor is more readily excited than the inhibitory, and causes violent movements, which the inhibitory centres of the brain cannot restrain without the greatest difficulty, though they are readily controlled by the inhibitory ganglia in the spinal cord. A slight titillation excites the motor, but not the inhibitory spinal ganglia; a stronger pressure stimulates the inhibitory centres also, and thus arrests the movements without any action being required on the part of the inhibitory centres in the brain. We may try to explain this, by supposing that there are two distinct sets of nerves proceeding from the skin to the cord, one of them having the power to excite inhibitory, and the other to excite motor centres. Further, we must suppose that these sets of fibres are endued with different degrees of excitability, the motorial ones being stimulated by a slight touch, but the inhibitory ones only by a stronger impression.

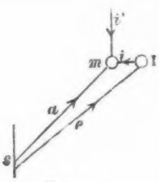


FIG. 3.

"This is represented in Fig. 3, where *s* is the skin; *a*, the fibres proceeding from it to the motor ganglion, *m* and *e*, those going to the inhibitory ganglion, I; *i* is the fibre by which I arrests the action of *m*, and *i'* that by which the brain exerts a similar action. The different fibres by which *m* acts on the muscles have not been introduced into the diagram.

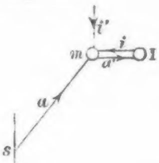


FIG. 4.

"This hypothesis, however, is a very clumsy one, and we explain the facts quite as well by supposing that there is only one set of afferent nerves (*a*, Fig. 4) from the skin to the cord, which transmit a slight impression only to the motor ganglia, *m*, but convey a stronger one along *a'* to the inhibitory ganglia I, also, which then react through *i* upon the motor ones. This latter supposition renders intelligible the fact that it is only when something is drawn quickly and lightly across the skin, so as to make a slight and transient impression on the ends of many sensory nerves, that tickling is felt. If the pressure on the skin is heavier, or if the motion over it is slow, the effect is quite different, and this is just what we might expect if a short and slight impression travels only to the motor ganglia, and a stronger or more lasting one goes to the inhibitory beyond them."

These diagrams themselves are suggestive of interference; but I did not in that paper say anything regarding it, contenting myself only with the term inhibition. One reason that prevented me from considering inhibition in animals as corresponding closely to the interference of light, was that the rapidity of transmission of nervous impulses was differently given by different observers, and indeed, according to Munk, it varies along the course of the same nerve.[1]

Unless the rate of transmission of impulses is constant, one cannot expect interference to produce inhibition. But in his observations on Medusæ, Mr. Romanes found that when the circumference of the bell in a medusa was cut into a long spiral strip, leaving only the centre of the bell uninjured, stimuli applied to the extreme end of the strip passed along it, and were delivered to the centre of the bell, just as if they had been applied to the central part itself—all passing at the same rate they did not interfere with one another. But when the strip was pressed upon or stretched, the passage of impulses was interfered with.

This seems to show that the rate of transmission of a stimulus along a conducting structure is a definite one, provided the structure remain under the same conditions. But still more instructive on this point are the experiments with the Ton-inductorium, invented by my friend Prof. Hugo Kronecker. Other observers have found that when a muscle is irritated by an interrupted current applied to its nerve, the tetanic contraction into which it would be thrown by twenty interruptions per second ceased when the interruptions became as frequent as 250 per second. By using an interrupted current induced by the vibrations of a magnetic rod, which gave out a definite tone, Kronecker and Stirling were able to throw the muscle into tetanus with no less than 22,000 interruptions per second. This success is probably to be attributed to the regularity and equality of the stimuli applied by Kronecker's method, while the fact that their predecessors got no tetanus with more than 250 interruptions per second is probably due to interference of the stimuli they applied.[2] Kronecker's observations show, I think, how definite must be the rate of transmission of stimuli along a nerve so long as it remains under the same conditions and give us a basis for extending the theory of interference from waves of light and sound to vibrations in nervous and muscular tissues.[3]

We are justified, I think, by these experiments in considering that interference may occur in the nervous system, and that one part may exercise an interfering or inhibitory effect upon the other, which is constant under normal conditions, but will be modified when these conditions are altered.

Let us now try to apply this hypothesis to the reflex action which we have just been discussing.

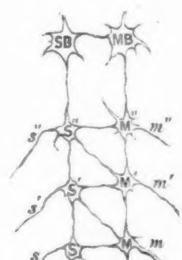


FIG. 5.

Let S, S' and S'' be three sensory cells in the spinal cord, M, M' and M'' motor cells, *s* and *s'* sensory nerves, and *m m'* motor nerves. S B is a sensory and M B a

[1] Archiv. f. Anat. u. Physiol. 1860, p. 798.

[2] It must be borne in mind, however, that the overtones of such a vibrating rod are in the ratio of *n*, 3 *n*, 5 *n*, &c., and not in that of *n*, 2 *n*, 4 *n*, like those of a vibrating string or pipe. Quincke (Poggendorff's Annalen, 1866, vol. viii. p. 182) failed to silence the sounds of such a rod by means of an interference apparatus.

[3] *Vide* Hermann's Handbuch d. Physiol Bd. i. Th. i. p. 44, and Bd. ii. Th. i. p. 39.

motor cell in the brain. When s is stimulated by a slight touch, the stimulus is transmitted up to S, thence to M, and down m to muscles, thus causing reflex contraction. This is increased when a number of slight touches are made over a limited surface, as in tickling, because then S and S′ are both stimulated, and more motor impulses are produced. But when harder pressure is made on s the stimulus, instead of being confined to S, is transmitted to S′ and thence to M, as well as direct from s to M. Thus two impulses are sent to M, which, starting at the same time from s, have had a different length to travel round. This different length, we suppose, is just sufficient to allow the impulses to interfere with one another in M and thus destroy each other's action in regard to motion. When s' is also irritated at the same time as s, the same interference is produced by a stimulus passing from S′ to S″, and then to M′. But at the same time that the relation of S′ S″ to M and M′ is such as to produce interference and inhibition in regard to motor impulses, the relation to each other is such that the impulses mutually strengthen one another on their way up to the brain, and thus the sensation which we perceive on firm pressure is more definite and better localised.

On this hypothesis each successive layer of sensory and motor cells in the spinal cord may have several different functions: (1) Each cell may exercise its own sensory or motor functions in relation to the sensory or motor nerves connected with it; (2) it may exercise an inhibitory function on the sensory and motor cells above or below it, and also on other sensory or motor cells on the same plane with itself; (3) it may have a stimulating function on other cells above, below, or on the same plane as itself, increasing instead of abolishing their action.

The effect that any sensory or motor cell produces when stimulated is not determined then simply by the *properties* of the cell itself, but by its *relations* to other cells or fibres.

Motion, sensation, inhibition, or stimulation are not positive, but simply relative terms, and stimulating or inhibitory functions may be exercised by the same cell according to the relation which subsists between the wave-lengths of the impulses travelling to or from it, the distance over which they travel, and the rapidity with which they are propagated.

T. LAUDER BRUNTON

(*To be continued.*)

NOTES

M. JANSSEN was present at the sitting of the Academy of Sciences on Monday, for the last time before his departure from Paris. He is very busy preparing his apparatus.

BARON NORDENSKJÖLD so very carefully considers every step he takes that we may be sure he has satisfactory reasons for claiming the reward of 25,000 guilders (about 2000*l.*) offered by the Dutch three centuries ago to the discoverer of the North-east Passage. Some surprise is expressed at the Baron's claiming a reward which lapse of time may be considered as having rendered obsolete. At the time it was offered the North-east Passage was regarded as a sea-route of the highest commercial importance, though this idea has been long exploded. Still to some extent Baron Nordenskjöld has shown that the old conception was not without justification, and although the passage is now of no value as a route to China and India, still the Swedish explorer has proved that as a trade-route it may be rendered of considerable value. Moreover as he is so disinterested, ardent, and successful a pioneer of science, we should be glad if the Dutch Government cheerfully admitted the claim. It may be remembered that the much larger reward offered by our own Government to the discoverer of the North Pole was withdrawn many years ago.

AT the last meeting of the Royal Swedish Geographical Society, on the proposal of Baron Nordenskjöld, the greatest honour at the disposal of the Society, the *Vega* gold medal, was conferred on Mr. Stanley. The medal, struck *in memoriam* of the *Vega* expedition "for geographical discovery," has only been twice before conferred—viz. in 1881, on Baron Nordenskjöld, and in 1882, on Capt. Palander.

IN 1880 the Belgian Academy proposed, as a prize-subject, the relations between physical and chemical properties of simple and compound bodies (completion of the knowledge of these by new experiments). The prize (a gold medal valued at 1000 francs) has been awarded to M. De Heen, engineer at Louvain. His memoir is an extension of one previously sent in, which gained high approbation for original work and results, but was thought badly-proportioned, so that the subject was re-proposed. The work is in five sections, dealing successively with specific heats, dilatability of solids and liquids by heat, changes of state in relation to chemical composition, capillarity, and (here without original researches) molecular volumes, refraction, spectral analysis, and absorbent power of bodies for heat. The ample *résumé* M. Spring gives of this memoir (*Bull. Belg. Acad.* No. 12) indicates matter that must be of much interest and value to the physicist and the chemist.

PERHAPS never in the history of science, the *Lancet* says, has a distinguished career equalled in its length that of M. Chevreul, whose name is best known in this country in connection with his investigations on colour; and it is probably altogether unique for a *savant* to be able, at one of the most distinguished scientific societies in the world, to refer to remarks which he made before the same society more than seventy years previously. A few days ago M. Chevreul made a communication to the Académie des Sciences, and at its close he observed: "Moreover, gentlemen, the observation is not a new one to me. I had the honour to mention it here, at the meeting of the Académie des Sciences, on the 10th of May, 1812"!

THE death is announced of the Silesian botanist, Herr Johann Spatzier, aged seventy-seven; also of Herr Josef Knörlein, the entomologist, at Linz, on February 12, aged seventy-seven.

MOUNT ETNA is very active and ejects red-hot lava. At night the glare is constantly visible. A violent shock occurred on February 15.

WE find in the last number of the *Izvestia* of the Russian Geographical Society a note, by Prof. Lenz, on the cosmical dust collected by M. Marx at the meteorological station of Yeniseisk. After having vainly searched for traces of cosmical matter, as he was advised to do by Baron Nordenskjöld, he discovered it finally on October 31, 1881. The wind was blowing in the evening with great force from the west, and during the night it turned into a strong gale, with some snow and rain. When M. Marx measured next morning the amount of water in his pluviometer, he remarked that it had a considerable quantity of suspended matter of a brick-red colour. After careful analysis this matter proved to consist of iron, nickel, and cobalt. Prof. Lenz does not doubt that the red dust found by M. Marx had a cosmical origin, and points out that it was observed on a day very near to the appearance of the November meteors.

AT Monday's meeting of the Paris Academy of Sciences, M. Tresca read a paper full of facts on the experiments tried at the Gare du Nord. Deducting certain work for the mechanical transmission to the generator, the result was 42 per cent. of energy conveyed instead of 35 per cent. with a smaller

velocity, but without deducting this work the alteration was very slight, 33 per cent. instead of 32 per cent.

THE second annual general meeting of the members of the London Sanitary Protection Association was held on Saturday at the rooms of the Society of Arts, under the presidency of Prof. Huxley. From the report of the council, presented to the meeting, it appeared that 368 new members had joined the Association during the year, and there was a total of 533 members. The total number of houses inspected was 362, and in the greater number of these serious errors in the sanitary arrangements of the houses were found and corrected. Twenty-one of them, or 6 per cent., were found to have the drains choked up, and no communication whatever with the sewer; all the foul matter sent down the sinks and soil-pipes simply soaking into the ground under the basement of the houses. In 117 houses, or 32 per cent., the soil-pipes were found to be leaky, allowing sewer-gas, and in many cases liquid sewage, to escape into the house. In 137, or 37 per cent., the overflow pipes from the cisterns were led direct into the drains or soil-pipes, allowing sewer gas to pass up them, and contaminate the water in the cisterns, and in most cases to pass freely into the house. In 263, or nearly three-fourths of the houses inspected, the waste-pipes from baths and sinks were found to be led direct into the drain or soil-pipes, thus allowing the possibility of sewer gas passing passing up them instead of being led outside the house, and made to discharge over trapped gullies in the open air as they should be. Prof. Huxley moved the adoption of the report, and stated that he had found himself unable longer to act as president of the association, owing to the increasing demands upon his time and energies. He was glad however to say that the Duke of Argyll had consented to succeed him in that post. The second annual meeting of the Sanitary Assurance Association was held at the office, Argyll Place, Regent Street, W., on Thursday. In the absence of Sir Joseph Fayrer, Prof. T. Hayter Lewis, F.R.I.B.A., was elected to preside. The secretary read the report of the council for the year 1882, from which it appeared that the inspection of houses, supervision of work, and issue of certificates had been continued on the plan initiated by the association in 1881. The financial statement showed that considerable progress had been made since the issue of the first report. The increase during 1882 had been nearly double that of 1881.

PART 2 of vol. ii. of "The Encyclopædic Dictionary," published by Messrs. Cassell, extends to the word Destructionist. The present instalment seems quite up to the standard of those already published, though for a work of such extent we think the account of the corona of the sun inadequate. On the other hand, to illustrate the term Darwinism, we have half a column biography of Charles Darwin.

THE last number of the *Izvestia* of the East Siberian Geographical Society, which has just reached us, contains a letter from M. Yurgens, chief of the meteorological station at the mouth of the Lena. When leaving Yakutsk with his companions, Dr. Bunge and M. Eigner, he took with him, besides provisions for eighteen months, a wooden house 42 feet long and 21 feet wide, 40 cwts. of petroleum, two cows with a calf, plenty of hay, bricks, lime, and even moss and clay, as there is no clay in the delta of the Lena. As is unfortunately too often the case with such expeditions, the barometers went out of order, and the observers found great difficulty in filling and boiling them again, so that the new meteorological station at Olekminsk has remained without a barometer. On this subject a correspondent writes: "A new portable barometer would be really an immense benefit for countries like Siberia, but in the meantime would it not be advisable for second-rank meteorological stations to make use of the aneroid? Of course the correction of each aneroid changes slowly but continuously, so that an uncontrolled aneroid has no value at all; but would it not be possible to control it, say every fortnight, by means of a hypsothermometer—a most reliable instrument if the observer follows the advice of Dr. Wild—and, after having boiled the water, leave the thermometer to cool, and make use only of a second reading, which is made when boiling the water for a second time. The observations of Dr. Wild, repeated by M. Krapotkin at the St. Petersburg Physical Observatory on five hypsothermometers taken from an optician's shop, proved that they were most reliable if the above-mentioned precaution were used. Might it not be useful to repeat these observations on hypsothermometers on a larger scale, in order to ascertain the degree of accuracy that might be expected from these instruments, which highly recommend themselves to travellers, and especially for small meteorological stations, by their portability?"

AN avalanche, or rather a landslip, took place at Gudvangsören, in the remote and narrow Nærö valley, in Norway, at the end of January last. The quantities of earth and stone precipitated into the valley destroyed several farms, and killed two women. Landslips have previously occurred in this valley.

IT is remarkable that a disease like leprosy should flourish in Norway. From the returns just published this appears however to be the case, although we are happy to say that the number of afflicted is decreasing. At the end of 1875 there were 2008 patients reported in the country. At the end of 1880 the number had fallen to 1582. The disease is stated to be due to the consumption of food in an unwholesome condition, particularly fish, and also to uncleanliness.

ON February 5, at 6.45 p.m., a meteor of unusual size and appearance was observed near Arvika, in Sweden. An observer who happened at the time to be passing a lake—Glasfjorden—states that he first observed the meteor high on the horizon, going from south-east to north-west, when, after about eighteen seconds, it suddenly changed its course to south-east. During its progress to north-west, calculated at eighteen seconds, the meteor made several digressions from its plane, while its size varied from that of an ordinary star to that of the sun, sometimes emitting a white, at others a yellow light, and at times discharging showers of sparks. At the point of changing its direction, when it was so near the surface of the lake that its path was reflected therein, it possessed a distinct tail, and with this adjunct it passed out of the range of sight in a south-easterly direction, after being observed for nearly fifty seconds.

AT Iserlohn (Rhenish Prussia) the fall of a meteorite was observed by several persons on the evening of February 1. Next morning the meteorite was found, having penetrated deeply into the hard-frozen soil of a neighbouring garden. Its weight is 165 grammes, its size that of a goose's egg. The surface is of a glistening black, and the point seems broken off.

A NEW substance, remarkable for its intense sweetness, being much sweeter than cane-sugar, has been lately found by Dr. Fahlberg in the course of some investigations on coal-tar derivatives (*Journ. Frank Inst.*). He designates it *benzoic sulphinide*, or *anhydrosulphamine benzoic acid*.

MR. H. HEATHCOTE STATHAM will give the first of two lectures, at the Royal Institution, on "Music as a Form of Artistic Expression," on Saturday, March 10. The subject of Prof. Tyndall's discourse on Friday evening, March 16, is "Thoughts on Radiation, Theoretical and Practical."

ON February 11, at 9.50 a.m., an earthquake was noticed at Szigeth (Hungary). It lasted four seconds. It was also felt in the Bosnian village of Looskrupa and its neighbourhood.

AN Electro-technical Exhibition will be opened at Königsberg on April 15 next.

THE additions to the Zoological Society's Gardens during the past week include two Common Marmosets (*Hapale jacchus*) from Brazil, two Brazilian Caracaras (*Polyborus brasiliensis*) from Uruguay, presented by Mr. Donald F. Mackenzie; a Rook (*Corvus frugilegus*), a Common Magpie (*Pica caudata*), British, presented by Mr. C. L. Sutherland; a Lump Fish (*Cyclopterus lumpus*), British Seas, presented by Mr. W. K. Stanley; a Bonnet Monkey (*Macacus radiatus*) from India, deposited; a Humboldt's Saki (*Pithecia monachus*) from the Amazons, a Squirrel Monkey (*Chrysothrix sciurea*) from Guiana, two Red-vented Bulbuls (*Pycnonotus hæmorrhous*) from India, a Crested Black Eagle (*Lophoaëtus occipitalis*) from West Africa, a Cirl Bunting (*Emberiza cirlus*), British, purchased; a Zebu (*Bos indicus* ♂), five Brown-tailed Gerbilles (*Gerbillus erythrurus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

CERASKI'S VARIABLE STAR, U CEPHEI.—On comparing Dr. Julius Schmidt's observations of this star in 1882, with minima determined by the same observer in the autumn of 1880, there results a period of 2·49289 days, or 2d. 11h. 49m. 46s., on the assumption that it is regular or equable. Dr. Schmidt suspected a marked variation in the period, each successive period being 5·25 seconds longer than the preceding one. The following are the times of minima in March, which will be observable here:—

	h.	m.		h.	m.		h.	m.
March 2 ...	12	43	March 12 ...	12	2	March 22 ...	11	21
7 ...	12	22	17 ...	11	41	27 ...	11	0

THE TOTAL SOLAR ECLIPSE OF 1901, MAY 17.—The ensuing return of the solar eclipse in May next, for the observation of which this country with France and the United States have despatched observers to the Pacific, will take place on May 17, 1901, when the duration of totality will be even longer than in the present year, and the part of our globe where observations will be most advantageously made will be rather more accessible than in the approaching eclipse. The following are approximate elements of the phenomenon:—

G.M.T. of conjunction in R.A. 1901, May 17, 17h. 28m. 14s.

	°	′	″	
Right ascension	54	15	36	
Moon's hourly motion in R.A.		39	30	
Sun's ,, ,, ...		2	29	
Moon's declination	19	1	34	N.
Sun's ,, ...	19	23	49	N.
Moon's hourly motion in decl.		5	14	N.
Sun's ,, ,, ...		0	34	N.
Moon's horizontal parallax		60	57	
Sun's ,, ,, ...		0	9	
Moon's true semi-diameter		16	36·5	
Sun's ,, ,, ...		15	48·9	

Hence the middle of the general eclipse occurs at 17h. 33m. 25s. G.M.T. The central phase commences in longitude 39° 57′ E., latitude 27° 21′ S; the eclipse is central and total with the sun on the meridian in longitude 97° 0′ E., latitude 2° 7′ S., and the central phase ends in longitude 157° 8′ E., latitude 13° 0′ S. If we calculate directly for a point in 100° 59′ E. and 1° 14′ S., which is close upon the central line and to the west coast of Sumatra, we find—

	h.	m.	s.	
Beginning of totality, May 18, at	0	22	11	Local mean time.
Ending ,, ,,	0	28	35	

Hence the duration of total phase is 6m. 24s. The sun's altitude is 68°.

THE VARIABLE STAR, S VIRGINIS.—This object, which varies between 5·7m. and 12·5m., appears to have escaped observation during the last few years. Prof. Schönfeld assigns a period of 374 days, according to which, reckoning from his tabular maximum, the last would have occurred on October 25, 1882, and if the minimum falls about 119 days before maximum, as stated by the Bonn astronomer, one will be due about July 8. This star has an intense reddish-yellow light: its position for 1883 is in R.A. 13h. 26m. 54s., N.P.D. 96° 36′.

There is a suspicion that another star in the vicinity varies through about two magnitudes, 8–10. Its place for 1883 is in R.A. 13h. 24m. 26s., N.P.D. 98° 58′.

THE BINARY STAR, ζ CANCRI.—Among several orbits recently calculated for this star by Dr. H. Seeliger, in an interesting memoir communicated to the Academy of Sciences at Vienna, the following is perhaps the most satisfactory:—

Passage of Peri-astron	1870·393
	° ′
Node	71 32
Node to Peri-astron on orbit	113 52
Inclination	10 53
Eccentricity	0·34327
Mean motion	−5°·8867
Semi-axis major	0″·8515
Period of revolution	61·154

This orbit gives for 1883·0, position 71°·1, distance 0″·88; and for 1885·0, position 61°·4, distance 0″·93.

GEOGRAPHICAL NOTES

As there seems to be some misunderstanding as to the route to be followed by Baron Nordenskjöld in his Greenland Expedition, we may say that we have good reason to believe that there is no intention to proceed along the west coast to Cape York. An attempt will certainly be made to add to our knowledge of the old Danish settlements on the south and south-east coast, but the chief purpose of the expedition is to further explore the east coast, and to penetrate the interior. Baron Nordenskjöld will be accompanied by a complete scientific staff; but we believe he does not intend to divulge the details of his plan till after the expedition sails. He has made a thorough study of all that is known of Greenland; among other things he has published an elaborate investigation of the voyage of the Zeni. A Danish expedition, under Lieut. Holm, will also be sent to Greenland this year; it will be away two years.

THE Russian Geographical Society announces the early publication of the following works which it has already received:—A large work, by M. Mayeff, being a statistical and economical description of the Khanate of Bokhara; the report of M. Polakoff on his explorations in Sakhalin, with several maps, including the eastern coast; and a work, by M. Adrianoff, on the antiquities of the Altay and Sayan, with numerous drawings. These works will be published in the *Memoirs* of the Society, but each of them will appear separately, as soon as printed, without awaiting the completion of a volume, as was formerly the case, which caused great delay in the appearance of interesting papers.

AT the last meeting of the Caucasian Geographical Society, General Stebnitsky exhibited his new orographical map of Asia Minor and adjacent countries. The map is based on measurements of heights of about 1500 places. Dr. Radde made a further communication on his great work, "Ornis Caucasica," which is the result of his many years' travels in the Caucasus, and of the description of the collection of the Tiflis Museum, which contains no less than 4000 specimens of birds.

M. POLAKOFF, who was sent by the Academy of Sciences for the exploration of Sakhalin Island and of the coasts of the Pacific, spent last winter and spring at Taranka, in the Gulf of Patience, and has returned to Korsakovo with rich scientific collections. He will now begin the exploration of the coasts of Russian Manchuria. One part of his report has already reached the Geographical Society.

NEWS has been received at the Paris Geographical Society that the French had reached the banks of the Niger, Colonel Desborde having been obliged to cut his way through the Beledegou region. He fought a battle with the chief of Daba, after having crossed a stream called Baoulè. The victory was won by artillery, and the chief of Daba was killed, as well as a large number of his followers.

THE Danish Ministry received on February 24 a despatch from their representative in St. Petersburg, to the effect that the Samoyedes sent out to look for the *Dijmphna* and the *Varna*, had returned on January 6 to Liapine in the Obi basin, and reported that "neither had they seen any vessel at sea, nor heard of any shipwrecked crew."

In the last part of the *Bulletin* of the Paris Geographical Society for 1882, Dr. J. Montano describes his excursion into the interior and along the coast of Mindanao; Commander Gallieni gives a detailed narration of his mission to the Upper Niger and Segou; M. Aymonier describes the result of his excursion to Central Cambodia; a paper by the late Dr. Crevaux gives the leading results of his exploration of the Yary, Paron, Iça, and Yapura; and M. Dutreuil de Rhins has a paper on the observations of the transits of Venus.

In the new number (102) of the *Zeitschrift* of the Berlin Geographical Society we have the usual annual systematic list of new works, papers, and maps in all departments of geography published during the past year, a list indispensable to geographers, and which will be found useful by students of the many departments of science related to geography. In the *Verhandlungen* (No. 1, for 1883) Prof. Foerster has a paper on the expeditions for the observation of the recent transit of Venus, and Prof. Brauns a paper on the Island of Yezo. Interesting news from the various German expeditions in Africa will be found in Heft 4 of Band iii. of the *Mittheilungen* of the German African Society, including a detailed account of Dr. Wissmann's journey across the continent, to which we referred last week. There are four letters from Herr Flegel on the progress of his Niger explorations, and several communications of great importance from the party stationed at Gonda, in East Africa, who are accumulating material of great value. They were arranging for a visit to Lake Moero according to the latest intelligence.

In a paper on the Gulf Stream in the *Bulletin* of the American Geographical Society (No. ii. 1882), Commander Bartlett gives some of the results of the examination of that current by the party in the *Blake* in the summer of 1881.

The principal paper in the February number of the *Bollettino* of the Italian Geographical Society is a narrative, with illustrations, by Lieut. Bove, of his mission to South America.

THE OPENING OF THE FINSBURY TECHNICAL COLLEGE

We have already given in our issue of February 1 (p. 318) a brief outline of the curriculum of study to be pursued at the Finsbury Technical College, in our review of the programme of instruction recently published. The new college was opened on Monday, February 19, with an address by Mr. Philip Magnus, the Principal of the College, and Director of the Institute. The address was delivered in the hall of the Cowper Street School, none of the lecture-rooms of the new college being large enough for the purpose. There were present about 1200 persons, chiefly artisans. Sir Frederick Bramwell occupied the chair, and among those on the platform were Sir Sydney Waterlow, Dr. Siemens, Professors Roscoe, Abel, Carey Foster, Adams, Ayrton, Huntington, Armstrong, and Perry, Dr. Gladstone, Mr. H. T. Wood, Mr. J. G. Fitch, Mr. Swire Smith, Mr. Matthey, Mr. Owen Roberts, Mr. John Watney.

Mr. Magnus commenced by indicating some of the incorrect ideas still prevalent on the subject of technical education. He considered that any definition ought to be expressed in very wide terms, so as to be referable to the different kinds of training to which the term technical education applies. He himself proposed to call that education, training, or instruction technical which had a direct reference to the career of the student who received it. Thus considered, technical education was no new thing, except in its reference to careers called into existence by recent developments of science. It was because the system of education to which we had been accustomed was no longer the best preparation for actual work, and not because no relation hitherto existed between the boy's training and the man's career that such colleges were needed. The necessity of technical education he attributed to the invention of the steam-engine and the breaking-up of the apprenticeship system, and the tide which was pushing it forward would not subside until it had influenced the educational institutions of the country from the primary school to the university. The Council had been guided by the desire to supplement, and not to duplicate, existing educational machinery. The college consisted really of a day school for pupils entering between the ages of fourteen and seventeen, and an evening school for apprentices, workmen, &c. The former would give preparatory training to students for practical work in the factory or engineer's shop, and the evening department was intended to help those already at work to understand the principles underlying processes they saw exemplified in their daily work. The college was therefore a technical school of the third grade, and whilst the majority of the pupils would complete within it their instruction, some would proceed to the technical high school or central institution in course of erection at South Kensington. The college might claim to represent a new grade of school. It was not an institution in which any particular trade would be taught, except it were some art industry, nor would it teach the excellence, precision, and rapidity of execution which could only be acquired in the workshop or factory, where, under the severe strain of competition, salable goods were being manufactured. Proceeding to indicate the course of instruction to be given, Mr. Magnus explained that on entering the institution, the student would generally declare whether he wished to be trained as a mechanical engineer, an electrical engineer, or with a view to some branch of chemical industry, or whether he wished to study applied art, and the subjects would be taught with special reference to the career of the student. The teacher would keep steadily in view the purpose to which the student would apply his knowledge. The work would be essentially practical, and more would be done in the laboratory than in the lecture-room, the lectures forming rather a commentary on the practical work than the practical work an illustration of the teaching of the lecture-room. The main purpose was not to turn out scientists, but to explain to those preparing for industrial work the principles that had a direct bearing on their occupation, so that they might be able to trace back the principles they saw to their causes, and thus substitute scientific method for mere rule of thumb. Of the four departments of the College—electrical engineering, mechanical engineering, chemistry, and applied art—that of electrical engineering promised to be the most attractive to students. But there was an intimate connection between the different branches of science not to be lost sight of in the training of a student in any one department. In the course of his remarks on the evening school and the curricula arranged for artisans engaged in various industries, Mr. Magnus referred very pointedly to the narrow view which adult workmen generally take of their own educational requirements. He impressed upon this class of students the necessity of acquainting themselves with branches of industry cognate to their own, and suggested that one of the objects of technical education was to correct the cramping and narrowing influences of extreme division of labour. He referred to a fact told him by a medical friend, that a student refused to dissect the abdominal cavity because, as a surgeon, he intended to occupy himself exclusively with diseases of the eye, and stated that this view of technical instruction needed to be strenuously resisted. He also insisted very strongly upon the importance of artisan students gaining a knowledge of the principles of science, as helping them to deal with unexpected and exceptional cases of difficulty certain to arise in their ordinary work. Mr. Magnus referred at some length to the methods of teaching to be adopted in the college, showing that there was no real opposition, as sometimes stated, between technical instruction, properly understood, and mental culture—that science might be so taught as to yield mental discipline, and yet at the same time have a direct reference to the career or occupation of the student. Mr. Magnus further explained the exact position which the Finsbury Technical College is intended to occupy in the Institute's general scheme of technical education. He illustrated this part of his address by a diagram showing the Bavarian school system, which he said was pronounced by many educational authorities to be the best in Germany, and the technical part of which was in many respects similar to the series of schools which the Institute is engaged in establishing. Mr. Magnus attached great importance to the Central Institution, now being erected in South Kensington, as crowning the educational ladder which pupils from the primary schools should have the opportunity of ascending, and as influencing, in the same way as the Universities at present influence, the entire system of education pursued in the series of schools leading up to them. The speaker did not omit to refer to the Applied Art Department which has recently been added to the College, and in which the instruction he said would be specialised according to the particular occupation of the student. In conclusion Mr. Magnus hoped the college would do much to wipe away the reproach of the neglect of technical education under which the country had hitherto lain compared with other countries. On

the motion of Dr. Siemens, seconded by Prof. Abel, Mr. Magnus was thanked for his address. In seconding a vote of thanks to the Chairman, Alderman Sir Sydney Waterlow said their success was attributable to the generous aid of the Livery Companies, and he appealed to them to render permanent those grants hitherto given at their pleasure.

SCIENTIFIC SERIALS

The Journal of Anatomy and Physiology, vol. xvii. Part 2, January, 1883, contains:—On a method for the estimation of urea in the blood, Part 1, by Dr. J. B. Haycraft.—On the homologies of the long flexor-muscles of the feet of Mammalia, with remarks on the value of their leading modifications in classification, by Dr. G. E. Dobson (Plates 4-6).—On obliterative endarteritis and the inflammatory changes in the coats of the small vessels, by Dr. R. Saundby (Pl. 7).—The presence of a tympanum in the genus Raia, by G. B. Howes (Pl. 8).—The ligamentum teres, by J. B. Sutton (Pl. 8).—Fibrinous coagula in the left ventricle, by Dr. A. M'Aldowie (Pl. 9).—A simple method of demonstrating the nerves of the epiglottis; the trachealis muscle of man and animals; the sulphocyanides of ammonium and potassium as histological reagents, by Dr. Wm. Stirling.—A new theory as to the functions of the semicircular canals, by Dr. P. M'Bride.—Some points on the myology of the common pigeon, by W. A. Haswell, M.A.—The action of saline cathartics, by Dr. M. Hay (Pl. 10).—Some variations in the bones of the human carpus; a first dorsal vertebra with a foramen at the root of the transverse process, by Prof. W. Turner, M.B.—Multiple renal arteries, by Dr. Macalister.—Division of the scaphoid bone of the carpus, with notes on other varieties of the carpal bones, by Dr. R. J. Anderson.

Journal of the Royal Microscopical Society, December, 1882, contains:—On some organisms found in the excrements of the domestic goat and the goose, by Dr. R. L. Maddox (Pl. 7).—On a further improvement in the Groves-Williams ether-freezing microtome, by J. W. Groves.—Summary of current researches relating to zoology and botany (principally Invertebrata and Cryptogamia), microscopy, &c., including original communications from Fellows and others.—The proceedings of the Society.

February, 1883, contains:—Observations on the anatomy of the Oribatidæ, by Dr. A. D. Michel (plates 1 and 2).—On a minute form of parasitical Protophyte, by G. F. Dowdeswell, M.A.—On the use of incandescence lamps, as accessories to the microscope, by H. C. Stearn, with figure—and the usual summary of current researches relating to botany and zoology.

Revue internationale des Sciences, December 15, 1882, contains:—On the Nofoures of New Guinea, by Élie Reclus.—On movements and sensibility in plants (finis), by J. L. de Lanessan.—Reviews.—Notices of learned Societies: the Academy of Sciences, Paris; the Academy of Sciences, Amsterdam.

January 15, 1883, contains:—On the localisation of the cerebral functions in the cerebral hemispheres in man and animals, by Julius Nathan.—On the development of colours in flowers, by H. Müller.—On cell-division or cytodieresis, by L. F. Henneguy.—On the vaginal stopper in rodents, by Dr. Lataste.—On the adulterations in provisions in Paris, by M. Egasse.

Zeitschrift für wissenschaftliche Zoologie, Bd. 37, Heft 4, December 22, 1882, contains:—On the Coelenterata of the South Sea, No. 1.—On *Cyanea annaskala*, nov. sp., by Dr. R. v. Lendenfeld, of Melbourne (Plates 27 to 33; Pl. 27, a coloured representation of the new species).—Contribution to the anatomy, developmental history, and general biology of *Trombidium fuliginosum*, Herm., by H. Henking (Plates 34-36).—On some facts in the life-history of freshwater polyps, and on a new form of *Hydra viridis*, by Wm. Marshall, of Leipsig (Pl. 37).—Supplementary remarks on Dinophilus, by Dr. E. Korschelt.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, February 22.—"On the Effects of Temperature on the Electromotive Force and Resistance of Batteries," by W. H. Preece, F.R.S.

That heat has considerable influence on the condition of galvanic elements is well known, and it has been investigated by De la Rive, Faraday, Daniell, and many others. Some attribute the result to increased chemical affinity, and others to increased conductivity of the liquid, but no one has eliminated the effect on electromotive force from that on internal resistance with the view of expressing each in definite measurement. This the author has done. Special apparatus was made, so as to vary the temperature, and a very careful series of experiments were made upon Daniell, Leclanché, and bichromate of potash cells, measuring the electromotive force and resistance at each change of temperature in rising and falling between 0° and 100° C. The results are tabulated and plotted out as diagrams.

The conclusions are (1) that the E.M.F. is not materially affected by changes of temperature; (2) that the internal resistance is affected very materially according to a fixed law that apparently varies with every cell. A Daniell's cell at 100° C. has only one-third the resistance it has at 0° C. Between 10° and 20° C. it falls one half. Bichromate and Leclanché cells, though much reduced, are not reduced to the same extent; (3) when a liquid is warmed up, its resistance at the same temperature in cooling is greater than when it was being warmed up, and it takes a very long time (fifty hours) to recover its normal condition.

Chemical Society, February 15.—Dr. Gilbert, president, in the chair.—It was announced that a ballot for the election of Fellows would take place at the next meeting (March 1).—The following proposed changes in the list of officers were also announced:—Prof. G. D. Liveing and Dr. A. Voelcker as vice-presidents instead of Professors J. Dewar and A. V. Harcourt; Prof. Dittmar, Dr. W. R. E. Hodgkinson, Messrs. P. D. Howard, and R. Meldola as members of Council instead of Dr. T. E. Thorpe, and Messrs. F. D. Brown, J. M. Thomson, and W. Thorp.—The following papers were read:—On some derivatives of diphenylene ketone oxide, by A. G. Perkin. During the preparation of this substance from salicylic acid and acetic anhydride, a body was noticed which was separated out as transparent, satiny plates containing 75·2 per cent. carbon, and 4 per cent. hydrogen. The author has also investigated the action of nitric acid, of bromine, and of sulphuric acid on the above substance.—On α-ethyl valerolacton, α-ethyl β-methyl valerolacton, and on a remarkable decomposition of β-ethyl aceto-succinic ether, by S. Young.

Anthropological Institute, February 13.—Prof. W. H. Flower, F.R.S., president, in the chair.—Mr. Colquhoun read a paper on the aboriginal and other tribes of Yünnan and the Shan country. Mr. Colquhoun first dwelt upon the races of the South China borderlands. Between Canton and Nan-ning (one of the important towns on the Si-Kiang in Kwang-si), the inhabitants met with were pure Chinese. West of that to the Yünnan frontier, a mixed population on the river and aboriginal tribes in the interior were found. Throughout Yünnan the chief population consisted of Shans disguised under a great variety of tribal names. Lo-lo and Miao-tzŭ aborigines were met with, as well as Thibetans under the name of Kutsung. On the west side of Yünnan Mahomedans are numerous, presumably the remains of the armies of Ginghis Khan. The costumes are most varied and picturesque, and the Shans and all the aboriginal people were kind, frank, and hospitable, and in these respects and in their feet being uncrushed offer a great contrast to the Chinese. Besides the tribes met with, Mr. Colquhoun pointed out that there were in the north and north-west Yünnan, as well as in Ssŭ-chuan, four divisions, namely Li-ssŭ, Moro, Sifan, and Mantzŭ. A great similarity of language exists between the Lo-lo, Li-ssŭ, Sifan, and Burmese. The large area over which the Shan population is distributed was pointed out, and the habitat of the Karens and Lawas. The paper was illustrated by part of a collection of admirable photographs and sketches made during Mr. Colquhoun's late exploration, exhibited by means of the oxyhydrogen light. These form a portion of the illustrations which will appear in Mr. Colquhoun's forthcoming account of his late journey.

Geological Society, February 16th, Annual General Meeting.—J. W. Hulke, F.R.S., president, in the Chair.—The Secretaries read the Reports of the Council and of the Library and Museum Committee for the year 1882. The Council expressed their regret that, owing probably to the same causes as last year, they could announce no material advance in the prosperity of the Society, although its financial position was well maintained, the balance at the close of 1882 showing an increase over that of the previous year, notwithstanding a large expenditure upon the *Quarterly Journal*. The total number of Fellows was diminished by one, but there was an increase of nine in the number of contributing

Fellows. The Council stated that Mr. Ormerod had furnished a second Supplement to his Classified Index to the publications of the Society, bringing that work down to the end of 1882. The Council's Report further announced the awards of the various Medals and of the proceeds of the Donation Funds in the gift of the Society.

In presenting the Wollaston Gold Medal to Mr. W. T. Blanford, F.R.S., F.G.S., the President addressed him as follows: "Mr. Blanford,—The Council has awarded you its highest distinction, the Wollaston Medal, in recognition of your services to geology in Abyssinia, in Persia, and on the Geological Survey of the Indian Empire. They are so well and so generally known that it is not necessary for me to enlarge upon them here. Your writings, which treat of a not inconsiderable portion of the Eastern Hemisphere, comprise, in addition to geology, much information respecting zoology and the climates of the countries in which you served. Stamped with thoroughness and comprehensiveness, they constitute important additions to our knowledge of those regions. In conferring upon you this distinction, the Council of the Geological Society desires to mark its sense of their great value."

The President then handed the balance of the proceeds of the Wollaston Donation Fund to Prof. J. W. Judd, F.R.S., for transmission to Prof. John Milne, F.G.S., of Tokio, Japan, and addressed him as follows: "Prof. Judd,—The Council, in bestowing upon Mr. Milne the balance of the proceeds of the Wollaston Fund, wishes to mark its appreciation of the importance of his investigations into the phenomena of earthquakes, to which he has devoted so much time and attention during his residence in Japan. In handing to you this cheque for transmission to him, I would ask you to convey to him the hopes of the Council that this award may assist him in continuing those inquiries in Seismology which he has proved himself so well able to undertake."

In handing the Murchison Medal to Mr. Warington W. Smyth, F.R.S., for transmission to Prof. Heinrich Robert Göppert, F.M.G.S., of Breslau, the President said: "Mr. Warington Smyth,—The Council of the Geological Society has awarded one of its high distinctions, the Murchison Medal and a part of the proceeds of the Murchison Fund, to Prof. H. R. Göppert of Breslau, one of our Foreign Members, in recognition of his labours in fossil botany. The very large number of papers, 245, recorded in the Scientific List of the Royal Society under Prof. Göppert's name, testifies to the zeal and success with which he has cultivated this branch of biology during half a century. In asking you to transmit to him this Medal, I would desire you to express to him the high estimation in which this Society holds his work."

The President then handed to Prof. Morris, F.G.S., for transmission to Mr. John Young, F.G.S., the balance of the proceeds of the Murchison Donation Fund, and said: "Professor Morris,—The Council of the Geological Society, in awarding to Mr. John Young, of the Hunterian Museum, Glasgow, the balance of the proceeds of the Murchison Donation Fund, wishes to mark its appreciation of the value of his long-continued researches on the fossil polyzoa, especially those of the western part of Scotland, and of his investigations into the structure of the shells of the Carboniferous Brachiopoda. In his absence, I have much pleasure in placing the amount in your hands for transmission to him."

The President next presented the Lyell Medal to Dr. W. B. Carpenter, F.R.S., and addressed him in the following words: "Dr. Carpenter,—The Council of the Geological Society has awarded to you the Lyell Medal with (in compliance with the terms of the bequest) a portion of the proceeds of the Lyell Fund, in recognition of the great value of your investigations into the minute structure of invertebrate fossils and your deep-sea researches. Your contributions 'On the Structure and Affinities of the Eozoon Canadense,' 'On the Microscopic Structure of Nummulina, Orbitolites, and Orbitoides,' published in our *Journal*, your numerous papers on the intimate structure of shells, communicated to the Royal Society, and others published in the 'Annals and Magazine of Natural History,' your long-continued work on Foraminifera, your communications on Oceanic Circulation and on Abyssal Life-forms, all testify to a life-long devotion to branches of natural knowledge bearing on that department of science, the cultivation of which is the *raison d'être* of this Society. I count it a pleasure, Dr. Carpenter, that it has devolved upon me to hand you this Medal."

In presenting one moiety of balance of the Lyell Donation Fund to Mr. P. Herbert Carpenter, the President addressed him as follows: "Mr. P. Herbert Carpenter,—The Council of the Geological Society, in awarding to you a portion of the balance of the proceeds of the Lyell Donation Fund, desires to express its sense of the great value of your researches into the structure and relationship of several families of fossil Echinodermata. Your papers 'On some little-known Jurassic Crinoids,' 'On the Cretaceous Comatulæ,' 'On the Crinoids from the Upper Chalk,' and that read last session, 'On Hybocrinus, Baerocrinus, and Hybocystites,' are models of clearness and an excellent earnest of future work. The Council hopes that this award may aid you in continuing those lines of research in which you have already achieved signal success."

The President then handed the second moiety of the balance of the Lyell Donation Fund to Prof. Seeley, F.R.S., for transmission to M. E. Rigaux of Boulogne, and said: "Professor Seeley,—In conferring upon M. Rigaux a portion of the balance of the proceeds of the Lyell Donation Fund, the Council of the Geological Society desires to signify its estimation of the value it places on his researches in the Jurassic formations of the Boulonnais and their contained fossils. In asking you to transmit to him this cheque, I would desire you to convey to him with it our hopes that he may continue those lines of inquiry in prosecuting which he has attained so great success."

The President finally presented the Bigsby Gold Medal to Dr. Henry Hicks, F.G.S., and addressed him in the following words: "Dr. Hicks,—The Council, in conferring on you the Bigsby Medal as a mark of their appreciation of your labours amongst the oldest fossiliferous and the Archæan rocks of Great Britain and Ireland, feels, in your community of interests, a peculiar fitness in associating you with the memory of the founder of this distinction. Your numerous communications, beginning with one 'On the genus *Anopolenus*,' written in 1865, and culminating in that which you read at our last meeting, show to what good purpose you have employed the *horæ subsecivæ* of a busy professional life in prosecuting those researches which have had a distinct effect on geological thought. In handing to you this Medal, I would express the wish that you will continue to prosecute the line of inquiry to which you have so long and so successfully devoted your leisure hours."

The President then read his Anniversary Address, in which he passed in review the work done by the Geological Society during the past year, and discussed at considerable length a question arising out of this review, namely, the structural characters presented by the sternal framework and the limbs of Enaliosaurians, and the classificational value which they possess. He also referred to the discoveries which have been lately made in America of numerous remains of Pterosaurians, often of gigantic size; adverted to the proceedings of the International Geological Congress, held in 1881, at Bologna, and noticed, as one gratifying result of the latter, the establishment of an Italian Geological Society.

The ballot for the Council and Officers was taken, and the following were duly elected for the ensuing year:—President: J. W. Hulke, F.R.S. Vice-Presidents: Prof. P. M. Duncan, F.R.S.; R. Etheridge, F.R.S.; J. Gwyn Jeffreys, F.R.S.; Prof. J. Prestwich, F.R.S. Secretaries: Prof. T. G. Bonney, F.R.S.; Prof. J. W. Judd, F.R.S. Foreign Secretary: Warington W. Smyth, F.R.S. Treasurer: Prof. T. Wiltshire, F.L.S. Council: H. Bauerman; W. T. Blandford, F.R.S.; Prof. T. G. Bonney, F.R.S.; W. Carruthers, F.R.S.; Prof. P. M. Duncan, F.R.S.; R. Etheridge, F.R.S.; John Evans, F.R.S.; A. Geikie, F.R.S.; Rev. Edwin Hill, M.A.; G. J. Hinde, Ph.D.; Prof. T. M'Kenny Hughes, M.A.; J. W. Hulke, F.R.S.; J. Gwyn Jeffreys, F.R.S.; Prof. T. Rupert Jones, F.R.S.; Prof. J. W. Judd, F.R.S.; S. R. Pattison; J. A. Phillips, F.R.S.; Prof. J. Prestwich, F.R.S.; F. W. Rudler; Prof. H. G. Seeley, F.R.S.; Warington W. Smyth, F.R.S.; W. Topley; Prof. T. Wiltshire, F.L.S.

Physical Society, February 10.—Prof. Fuller in the chair.—Annual general meeting.—New officers elected for the year:—President: Prof. R. B. Clifton, M.A., F.R.S. Vice-presidents: Sir W. Thomson, Prof. G. C. Foster, F.R.S., Dr. T. Hopkinson, F.R.S., Lord Rayleigh, F.R.S., Prof. W. C. Roberts, F.R.S. Secretaries: Prof. A. W. Reinold, M.A., Mr. Walter Baily, M.A. Treasurer: Dr. E. Atkinson. Demonstrator: Prof. F. Guthrie, F.R.S. Other Members of Council: Prof. W. G. Adams, M.A., F.R.S., Prof. W. E. Ayrton, F.R.S., Mr. Shellford Bidwell, M.A., LL.B., Mr. W. H. M. Christie, M.A.,

F.R.S., Prof. F. Fuller, M.A., Mr. R. T. Glazebrook, M.A., F.R.S., Mr. R. J. Lecky, F.R.A.S., Prof. O. J. Lodge, D.Sc., Mr. Hugo Müller, Ph.D., F.R.S., Prof. J. Perry. New Member: Prof. Blyth of Anderson College, Glasgow.—Prof. Sylvanus P. Thomson explained his new graphical method of showing Jacobi's law of maximum rate of working, and Siemens's law of efficiency for dynamo-electric machines. This has been fully explained in the *Philosophical Magazine* and in the Cantor lectures on Dynamo-electric Machinery, delivered by Prof. Thomson. Prof. W. G. Adams pointed out the advantages of a graphic system of the kind.

The Institution of Civil Engineers.—February 20, Mr. Brunlees, president, in the chair. The paper read was on "Covered Service-Reservoirs," by Mr. William Morris, M. Inst. C.E. (of Deptford).

EDINBURGH

Royal Society, February 5.—Prof. Jenkin, F.R.S., vice-president, in the chair.—Emeritus Professor Blackie, in a paper on scientific method in the study of language, maintained that the true way to learn a foreign language was to learn it in the way a child learns its native language—conversationally; and that this method should be adopted for the teaching of the dead languages as well as for modern ones. Simple sentences expressing facts with which the pupil is in direct contact, the grammatical rule for construction being given after the construction is practically mastered by repetition, should lead by insensible gradations to more complicated sentences and ideas. The paper finished with some characteristic remarks about quantity and accent in Latin and Greek, which called forth criticism from Prof. Butcher and Mr. Marshall, Rector of the High School.—Prof. Tait, in a short note on the mirage problem, mentioned that he had come across a paper in Gorgonne's *Annalen* criticising Biot's great paper upon the subject. Thinking that possibly he might have been forestalled in some of his theorems, he had looked into the paper, the author of which, however, in attacking Biot, had given a construction which, if applied to the case of ordinary desert-mirage, would give a direct instead of an inverted image. Mr. Sang, in his criticisms on the paper, maintained that such mirage as was said to have been observed by Vince was impossible.

PARIS

Academy of Sciences, February 19.—M. Blanchard in the chair.—The following papers were read:—Observations of small planets, made with the large meridian instrument of the Paris Observatory, during the fourth quarter of 1882, by M. Mouchez.—Results of experiments made in the workshops of the Chemin de fer du Nord, on M. Deprez's electric transport of work to a great distance, by M. Tresca (See p. 399).—Note on the theorem of Legendre cited in a note inserted in *Comptes rendus*, by Prof. Sylvester.—Report on a memoir of M. Rosenstiehl, entitled "Researches on the Colouring-matters of Madder," by M. Wurtz. *Inter alia*, M. Rosenstiehl has found a new mode of formation of purpurine (decomposition of pseudopurpurine by heating with alcohol at 40°), and his discovery of the composition of pseudopurpurine (which is really a trioxy-carboxyl-anthraquinone) throws much light on several facts that were obscure. Madder contains only three glucosides, giving respectively pseudopurpurine, carboxyl-alizaric acid, and munjistine, or carboxyl-xanthopurpuric acid.—M. Hospitalier presented a note on the influence of the mode of coupling of dynamo-electric machines in experiments on transport of force to a distance.—Observations of the new planet (232) Palisa, made at the Paris Observatory, by M. Bigourdan.—Observations of the great comet *b* 1882, made with the Brunner equatorial of Toulouse Observatory, by M. Baillaud.—On a curious modification of the nucleus of the great comet, by M. de Oliveira Lacaille. On the evening of January 8 the nucleus was seen to be much elongated and subdivided into four small nebulosities in a line, with centres like stars of the 12th magnitude. At 9.30 a.m. next day there was a change in the relative position: the first nebulosity being more separated, and the second having taken its place, &c.—On the observation of the transit of Venus of 1882 at the Lick Observatory on Mount Hamilton, California, by Mr. Todd. He got 147 photographs, of which 125 are well fitted for micrometric measurement.—On the uniform functions of a variable connected by an algebraic relation, by M. Picard.—On the relations between co-variants, &c. (continued), by M. Perrin.—On the functions of several imaginary variables (continued), by M. Combescure.—On a question of divisibility, by M. de Polignac.—On the equilibrium of the elastic cylinder, by M. Schiff.—On crystals observed in the interior of a bar of cemented Swedish iron, by M. Stoltzer. These crystals of steel are not regular octahedra like those of pig-iron and iron.—On the immediate analysis of pozzuolanas, and on a rapid process for testing their hydraulic properties, by M. Landrin. The rapid process is attack with hydrochloric acid, and trial of the insolubles with lime-water. There is no possible comparison between the action of pozzuolanas and of their insolubles on lime-water.—On sulphocyanopropionine, by MM. Tcherniac and Norton.—On allotropic arsenic, by M. Engel. When arsenic is isolated by the wet or dry way under about 360°, it is amorphous, dark grey, brown, or black, and unalterable in moist air; and its density is between 4·6 and 4·7. Heated to 360°, it changes into arsenic with a density of 5·7,—the steel-grey arsenic of laboratories, which crystallises when formed from condensation of arsenic vapour about 360° or more.—On benzoyl-mesitylene, by M. Louise.—Researches on mesitylene, by M. Robinet.—Toxical power of quinine and of cinchonine, by M. Bochefontaine. The former has more active physiological properties than the latter. Both are convulsive, cinchonine more than quinine, and quinine is distinguished by its vomitive effects and depressing action on the central nervous system.—On the value of intercrossing of the movements of cerebral origin, by M. Couty. This intercrossing is not constant, and has not the value that has been attributed to it.—Vision of ultra-violet radiations, by M. de Chardonnet. The spectrum of the crystalline lens corresponds exactly to that of the visible spectrum. From observations of persons with the lens removed, the author concludes that the retina is sensitive to ultra-violet radiations that come to it (as well as visible radiations), at least to about the line S. Thus the crystalline lens alone limits the visible spectrum. The absorption of the long ultra-solar spectrum of the electric arc probably fatigues the eye.—Researches on the production of monstrosities by shocks imparted to hens' eggs, by M. Dareste. He produced tremors, and so monstrosities, by means of a beating apparatus used by chocolate-makers.—On the generation of cells of renewal of the epidermis and of epithelial products, by M. Retterer.—On M. Merejkowski's Suctociliates (second note), by M. Maupas.—On the structure of simple subterranean branches of adult Psilotum, by M. Bertrand.—On the conservation of solar energy, by M. Duponchel. He infers from peculiar circumstances of our epoch that the sun-spot period which has varied in the neighbourhood of ten years for 130 years, will be extended to fourteen for the present and the two following periods. The first maximum will be in 1885.—Imitation of diffraction-spectra by dispersion, by M. Zenger.—The second part of M. Grüner's geological description of the coal basin of the Loire was presented (with analysis) by M. Daubrée.

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